American Machinist

MAY 20, 1936

An Appreciation of the Automobile

AS AN ENGINEERING and manufacturing achievement the automobile is perhaps the most remarkable product of a remarkable age of machines.

A new kind of civilization has been built on the individual mobility which it provides. Its increasing reliability each year solidifies that foundation into greater security for its social superstructure. It turns the farmer from a rustic recluse into a social being; it forces the provincial sophistication of the city-dweller into contact with rural realisms.

The automobile's facility for giving pleasure is as varied as the fancies of Jupiter; as sure as the course of Apollo. So progressively has its aspect changed that it provides ever new emotional thrills for its most veteran users and freshly symbolizes future joys for the youngsters who have yet to envision its full spendor.

Wherever people work or play, the automobile runs and serves. It touches the daily life of more people than the telephone or the electric light; there are 26,000,000 automobiles in America, only 17,200,000 telephones. Only 21,113,000 American homes are wired for electricity. Ten people ride in automobiles for every one who rides a train.

The automobile ranks high in the scale of needs for the average American. It carries the world to our families and our families to the world. It ministers to our needs and our desires; to our necessities and our whims. It makes life more full; work more effective.

All this it does directly.

Indirectly its manufacture hurls social and economic influences into practically every major industry, service and trade. More than 20,000,000 people—one sixth of our population—are dependent for income on automobile activity.

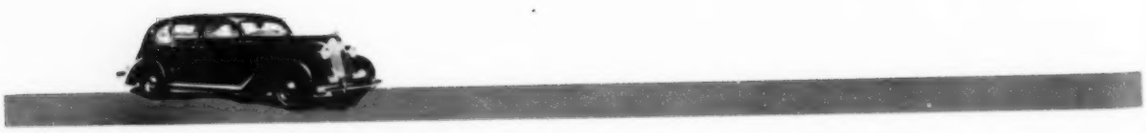
The vigor of its ever youthful thinking has touched the fuse of inventive genius throughout American industry.

No other machine of equal complexity and efficiency was ever developed so quickly. The automobile's demand for tools to function with unheard of accuracy and speed stimulated machine tool designers to impossible achievements. Its insistent cry for new materials encouraged the laboratories of the steel companies—and families of new alloys were born, families just as startling in the world of metallurgy as was the infant automobile itself in the world of transportation.

As an economic tool—as a purveyor of pleasure—as a social savior the American automobile well deserves the high place that has been accorded it.

Dexter S. Kimball

WALTER P. CHRYSLER
Chairman of the Board



Chrysler Corporation

Its Rise and the Reasons

ELEVEN YEARS ago Walter P. Chrysler disregarded the advice of conservative friends and put his faith in the willingness of the public to buy a better product, well designed, economically manufactured and aggressively sold. His product was a motor car and the capacity of the companies then in the field exceeded the estimated market by 35 per cent. He started with an added handicap of some twelve millions of debt. Last year Chrysler Corporation earned over eight dollars a share. Today it employs more than 60,000 peaple.

How was it done? Why has Chrysler played such an important rôle in the drama of transportation pictured in the foreword? Was it luck? Was it individual genius, or teamwork, or unlimited resources?

Let's look back a dozen years and see how it all started. At that time, Mr. Chrysler, seasoned and successful executive of Buick and General Motors, was trying to bring order out of the Maxwell mess for the bankers who had turned to him for help. He had just done a similar job, and done it well, for some of the same bankers at Willys-Overland. He and B. E. Hutchinson, treasurer of Maxwell, were making real progress in cleaning up Maxwell's debts, but they sensed the vital need for a new car that was more than the public had previously been able to get at the price offered.

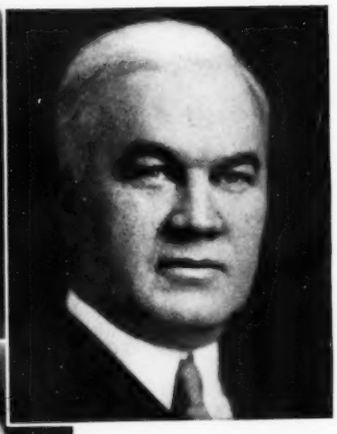
It turned out that there was a car, different in conception from anything then available, designed to combine large car comfort and performance in a smaller unit that would fit the smaller pocketbook. Developed by Fred M. Zeder, Owen Skelton and Carl Breer, this car represented the composite experience of three engineers who had been working together for upwards of twelve years, as a consulting firm and as engineers of automobile companies.

How the two were brought together is immaterial to this story. The important fact is that Mr. Chrysler started building the new car in the old Maxwell plant, because that marked the beginning of the amazing rise of the Chrysler Corporation to its present enviable position.

Chrysler Corporation's first car, Model 70, was an immediate success. As a companion car the old Maxwell

Courtesy Detroit Free Press

K. T. KELLER
President



B. E. HUTCHINSON
Chairman Finance Committee

J. E. FIELDS
Vice President

W. L. MITCHELL
Vice President

B. C. FOY
Vice President

four was continued as Model 58. But neither model looked like the car that would enable Mr. Chrysler to break into the mass market, an ideal that he had long cherished. He looked around, selected Dodge because of its unparalleled dealer organization and its enviable reputation for dependability, and bought it. The transaction was not as easily or quickly consummated as this brief statement implies. As a matter of fact it took a couple of years, but within two days after the final papers were signed and President Chrysler had handed Clarence Dillon the biggest single check ever written, Vice-President K. T. Keller had moved in and was operating the Dodge organization. No wonder the Chrysler crowd is conceded to be the fastest moving unit in the industry.

Fortified with adequate distributing facilities Mr. Chrysler was ready to launch his major attack on the low-price field. In 1928 he built a new plant in which to build Plymouths and started on his second big development. People said that it was one thing to crash the $1,500 market, quite another to take on both Henry Ford and General Motors' Chevrolet. Yet within five years he was able to tell the mass market to "look at all three."

To fill the price gap between Dodge and Chrysler models the De Soto was added shortly after.

Three separate and distinct sales organizations distribute Chrysler Corporation cars. One sells Chryslers, one sells De Sotos, one sells Dodges. And they all sell Plymouths. Nearly everybody who was anybody in the automobile industry knew that no such scheme as this would work, and said so. Unfortunately for the wiseacres' reputations it has worked extremely well, partly because each dealer has both the low-priced line and a higher-priced one to sell.

Besides its automobiles Chrysler Corporation makes Dodge trucks and Chrysler marine and industrial engines, and is also producing air compressors and complete summer and winter air conditioning units. It has a flourishing coil spring plant and is going places with its Oilite bearings.

As the supplement to this number of *American Machinist* shows, Chrysler operations are far flung. Production centers in Detroit but there are plants in Indiana, California and Canada, and foreign branches in London and Antwerp. Yet all of these enterprises are controlled by a single operating committee which meets every two weeks in Detroit. Every function of the corporation is represented on this committee by one or more individuals—production, engineering, finance, sales, industrial relations, public relations, purchasing, and legal. In a sense this group serves as a qualified jury to pass on the soundness of proposals but it has never been used as a brake on quick action. If it showed such a tendency it would be replaced instanter.

Functioning under the direction of

the operating committee are committees of plant managers, of superintendents, of engineers, of master mechanics, of plant protection men, of maintenance men, of planning supervisors, of industrial relations men. But in addition to the more or less formal meetings of groups there is a constant exchange of ideas and information between men doing similar jobs and men doing any other kind of job.

For instance, when a problem becomes acute many men have a hand in it before it is solved. Chrysler philosophy holds that collective responsibility for accomplishment gets better results than leaving an individual to fight through a snarl by himself.

The men at the top of Chrysler have been together so long that a family spirit prevails. It is encouraged by promotion from within. When Dodge was taken over, for example, Mr. Keller took very few men in with him. There was some rearranging but there was no general house cleaning.

Of a piece with this philosophy is the effort to have the men down the line take a part in setting corporation policy. Once set in that manner a policy can be carried into effect with considerable speed because the resistances have been removed beforehand.

One of the secrets of Chrysler efficiency is the fact that every one of its executives is on the job first, last and all the time. He can always be reached quickly if a decision is needed from him.

Another is that every man in a responsible position has pride in his own job and confidence in his own ability, and also a hearty respect for the ability of the men heading up the other corporation functions. As Mr. Hutchinson puts it, "I think K. T. Keller is the best production man in the business and Fred Zeder the best engineer. They are willing to admit that I can keep books."

How well he can keep them is clearly proved by Chrysler's financial picture. The feeling has been that bankers are better as friends than as partners for a fast stepping manufacturing organization, and they have been paid off as rapidly as possible. Profits have been used first to retire short term loans, next to build up the cash position, then for modest dividends. Debts are kept as low as possible, the Maxwell obligation having been cleaned up before Dodge was acquired, and the $60,000,000 debt that was part of the Dodge deal being practically paid off today. At the same time the corporation executives have spent freely on research and development and have maintained equipment in efficient shape. They have been willing to pay well for the best professional advice on such matters as taxes, public relations, legal questions and so forth.

Equipment requisitions clear through the staff master mechanic who works closely with Mr. Keller. Items involving an expenditure of more than $2,000 must get his personal O.K. New installations are not ordered until a pilot plant has proved successful.

In the pages that follow many of the details of this broadly sketched picture of a modern industrial corporation will be filled in. It will be clearer as you read this story of Chrysler why it was able to start from scratch, or a little behind that, and to win a place among the first three units in ten years.

Today the Chrysler Corporation, as it has been from its organization, is in the hands of men who have come up from the ranks. Some of the leaders have won engineering degrees, most of them served apprenticeships, a few did both.

They know their stuff, they know each other, and they know where they are going. There is, and has been, leadership of a high order, but in the last analysis the Chrysler Corporation is a close-knit group that functions as a unit. It has been an unusual privilege for the members of the editorial staff of *American Machinist* to get more intimately acquainted with Chrysler Corporation and its work.

Our only regret is that we have not been able to describe all of the excellent operations we were shown. Space limitations have made it necessary to select one department in this plant and another in that one. Our stories, therefore, are typical of Chrysler practice but by no means all-inclusive.

FRED M. ZEDER
Vice Chairman of the Board

Engineering Comes Into its

Adequately staffed, well equipped and comfortably housed, Chrysler engineering operates as a centralized function and takes time to train men for future needs

▼

IT SHOULD be obvious to anyone that engineering ranks high in a corporation where the director of engineering is vice-chairman of the board of directors. Fred M. Zeder, designer of the first Chrysler, close friend of Walter Chrysler and coworker for many years, holds that post in the Chrysler Corporation. Under his direction is one of the most interesting engineering organizations anywhere.

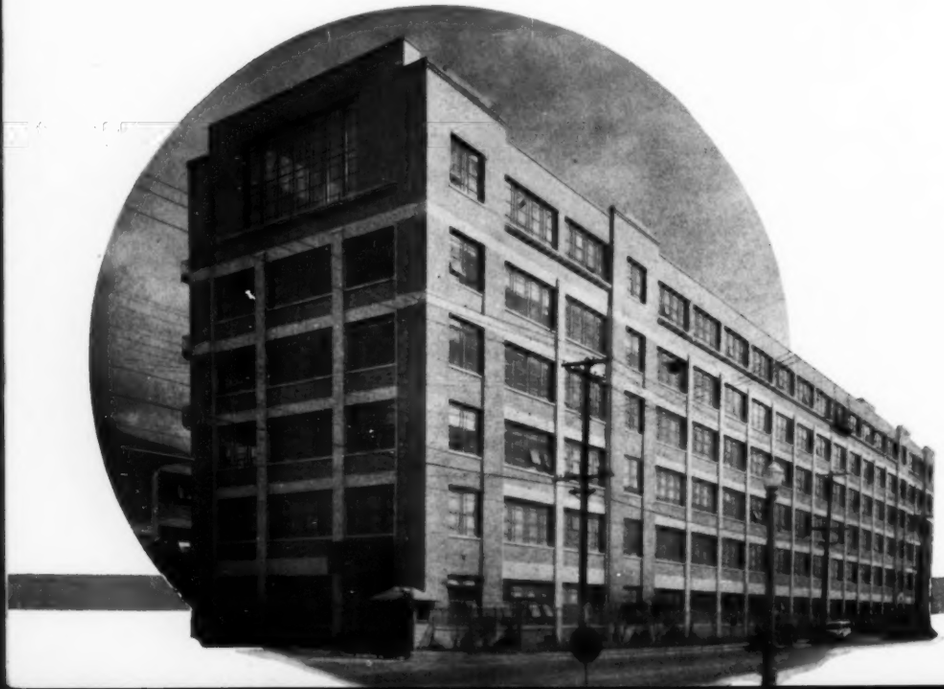
Perhaps the most remarkable thing about the Chrysler engineering staff is that it is headed by three men who have worked together for 25 years. Two of the three, Mr. Zeder and Carl Breer, served their engineering apprenticeships together at Allis-Chalmers Company in 1909. Owen Skelton, the other member of the triumvirate, joined Mr. Zeder shortly after Zeder entered the automobile industry. Since that time they have worked together for more than one automobile company, and they have functioned as a consulting engineering firm—Zeder-Skelton-Breer Engineering Company.

Directly under the three tops are two executive engineers. In turn, are the chiefs of the research, design, development, laboratory and patent divisions, who control various departments of the Engineering Division. Also, the Engineering Division is represented at each manufacturing plant by a resident chief engineer and staff, whose duty it is to iron out engineering and design problems that are encountered in the manufacturing of the product.

At this point one of the reasons for Chrysler Corporation's reputation of being able to "turn on a dime" becomes apparent. Centralized engineering makes for quick action once a policy has been set.

To illustrate: Suppose it is decided to have interchangeability in axle parts on more than one model. The axle is designed in the central engineering division chassis department under the supervision of the directing engineer, in compliance with all the requirements of the engineering executive committee and production division. Satisfying these requirements, it is not necessary to call for the approval of various other organized groups, but the axle as designed is released to production. This simple and direct process typifies the functioning of the Chrysler centralized engineering policy.

Closely associated with the engineering division is the cost estimating division. Cost analyses are made of every proposed design. Cooperation of the cost estimating division cuts down the



Chrysler's centralized engineering department with its various drafting rooms, offices, and research and testing laboratories is housed in one building surmounted by a large auditorium

Own

Three men who have worked together for twenty-five years head Chrysler engineering—Fred M. Zeder (center), Owen Skelton (left) and Carl Breer (right)

time element in getting a part or unit into production by establishing cost figures at the inception of a proposed design. It is typical of the care taken in the engineering division to assure that every possible production, sales and service angle has been analyzed before a design is released.

According to the Chrysler creed, the product itself and the performance of that product, are essentially engineering responsibilities. It is clearly recognized that what the customer cares about is how his car runs, how it looks, how much it costs to buy and how much it costs to operate. While every one of these factors is influenced by the manner in which other departments function, the engineers reason that no one, nor all of the other departments for that matter, could make up for any engineering misjudgment.

For this reason the Chrysler engineering department carries an unusual measure of responsibility. With this responsibility goes a corresponding independence that is very stimulating.

A few of the many achievements of which Chrysler engineers are proud are: aluminum pistons, steel bodies, Airflow design, distribution of weight, hydraulic brakes and Floating Power.

Physical facilities are adequate for any sort of engineering test, from a life test on a horn button to the famous Belgian Roll which simulates driving conditions on a viciously bad piece of road. Chrysler engineers do their testing not only inside, where conditions can be controlled and information obtained promptly and first hand, but also on the road under actual highway conditions.

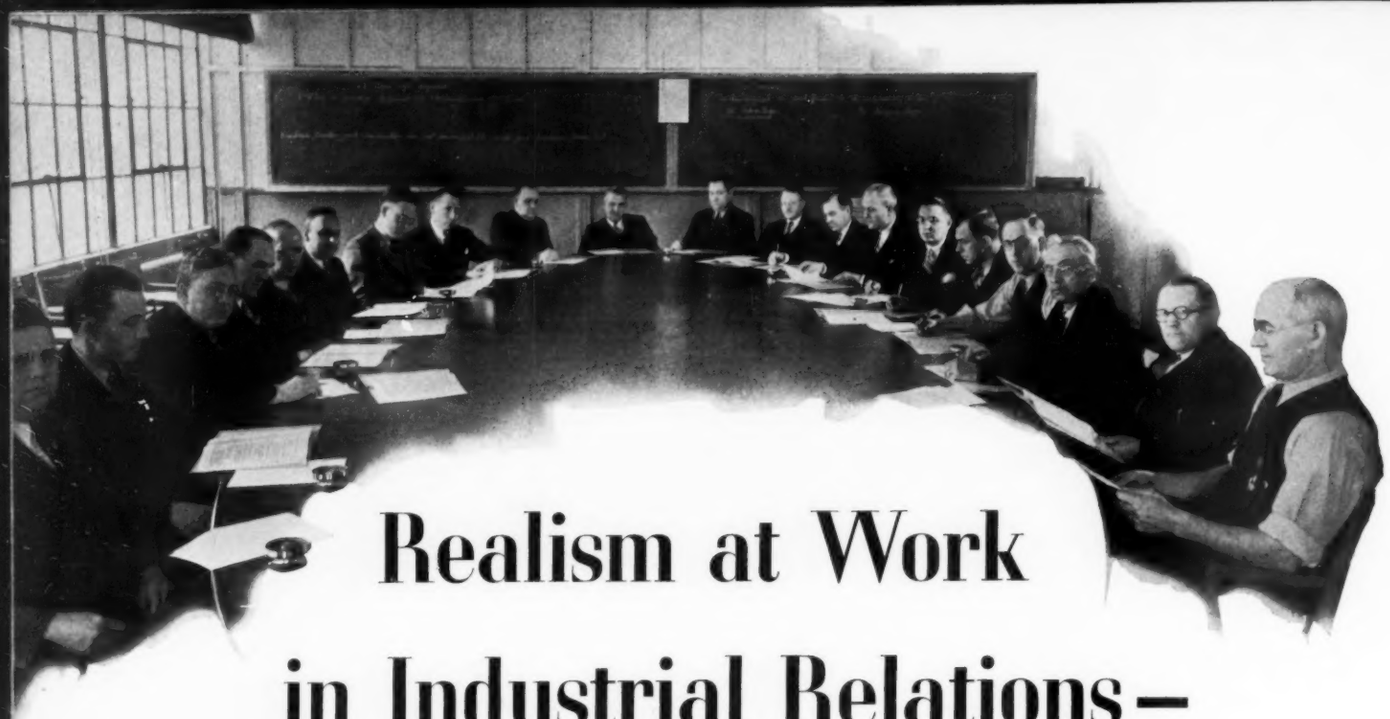
There are test stands for engine testing; hot and cold rooms where parts, units, and complete cars are subjected to severe and varying temperatures; a wind tunnel; a laboratory for testing electrical equipment; and all sorts of ingenious gadgets for destructive testing of chassis and body parts. There is a special department for carburetor development and testing; chemical and physical laboratories; a rubber laboratory; a radiator laboratory.

The body design department, with its artists, its modelers, its wood dummy builders; its color technicians and huge drafting corps, occupies two floors of the big engineering building. The chassis design group is fully as elaborate.

In the old Maxwell engineering building is the air conditioning research laboratory, where investigations of heat flow and humidification are carried on.

Also in this building are the class rooms of the Chrysler Institute of Engineering, the primary purpose of which is to develop recruits for future engineering personnel requirements. The Institute offers a two-year course of practical training to young university graduates holding degrees in engineering. These students progress through the laboratory departments and spend sufficient time in the shops to become acquainted with production problems. The Faculty of the Institute is drawn from the engineering personnel. Here, also, shop men are given an opportunity to obtain a high school and technical education through night classes where many of the post-graduate engineering students do the teaching. The Institute is chartered by the State of Michigan to issue high school credits as well as engineering degrees. Upon completion of the preparatory courses, selected students from among the shop men are awarded fellowships in any university they may wish to attend. The high school and preparatory school courses are open to all Chrysler employees up to the limit of the available space. How popular they are may be gleaned from the fact that there is a waiting list of 5,000.

No wonder Chrysler engineering is successful. Its unique system of centralized control is proven, its facilities are excellent, its provision for personnel growth well conceived, its foundation for permanency well established. Truly, engineering has come into its own here.



Realism at Work in Industrial Relations—

An Objective Appraisal

FACTORIES, like people, have personalities. That personality permeates especially relationships between management and men, just as the personality of an individual determines his ability to make and keep friends.

Among factories as among people it is easy to recognize the mean, the liberal and the profligate; the dictatorial, the fair and the mawkish; the cruel, the normal and the sentimental.

When the operations of an organization are closely integrated under a single management group, the organization personality tends to reflect the mental attitudes of the men comprising that group.

Chrysler operations are highly integrated. Chrysler has a personality. It is lusty, robust, two-fisted, single-purposed—and fair. It is above all realistic.

Chrysler has been made a good place to work primarily because its chief executives have been realists from the start. "Progress of a corporation must be accompanied also by the individual progress of those whose work it represents," Walter P. Chrysler says. His own early days in a machine shop, first as an apprentice and then as a journeyman mechanic have never let him forget that it is natural and reasonable for workmen to think first "What does it mean to me?"—then, "What does it mean to the company?"

When Chrysler distributed $2,300,000 among its employees a few months ago —$30 was the least anyone got—a statement, not a "message," went with it from President K. T. Keller. It was a straight-forward man-to-man document. No slightest flavor of feudalism hung about a single phrase. " . . . In authorizing this fund as an additional recognition of the services of its employees, the management wishes to express its appreciation of the cooperative efforts of the employees . . . it makes me very happy that the Corporation is in a position to pay the employees that extra amount *over and above the wages they have earned* . . . the wage rates we have paid are higher than 1929 level . . . we are endeavoring to offset effects of seasonal character of business on stability of employment and we hope to make further improvement notwithstanding practical difficulties."

From the workers' point of view, Chrysler realism has been extremely pleasant and beneficial ever since that day fifteen years ago when the former railroad shop mechanic took over the moribund Maxwell company. Sound aggressive business methods immediately turned the tide and gave promise of continuing operations—and jobs. By 1924 and 1925 Chrysler was in process of being born of the new vitality which Chrysler realism had injected into Maxwell operations.

Characteristically, the first thing that Chrysler did for the employees of his new corporation was to design and get into production an automobile that the public wanted and therefore was sure to buy. That had to be accomplished or there wouldn't have been jobs for anybody. Fostering of an industrial association enabling employees to establish extraordinary measures of mutual benefit; development of foreman training courses, apprentice training routines, and an institute of technology; inauguration of a unique laboratory of industrial hygiene; establishment of the *Chrysler Motors Magazine* and the Chrysler Choir; refinement of methods to bring about greater stability of employment; and setting up of an employee representation plan providing a chance for employees "to have an equal voice with management in deciding jointly all matters affecting wages and working conditions"—these and a host of other recognitions of the importance of human relationships in industry came later.

The psychological basis for Chrysler success in industrial relations probably is explained better in the following paragraph from the January, 1936 issue of *Chrysler Motors Magazine* than by hundreds of pages describing representation plans, industrial associations, labor stability curves and whatnot.

Referring to activities of the Chrysler Industrial Association, the paragraph reads:

"Neither K. T. Keller nor C. T. Winegar missed a single major concert, show, picnic, sports event, dance or party during 1935 so far as we can learn. Their *capacity for having fun themselves* is surpassed only by the pleasure they get in seeing others enjoy themselves." The italics are ours.

The spirit behind the administration of policies has been the important factor in building good morale at Chrysler, rather than the details of the policies themselves. Those policies, nevertheless, have been carefully worked out to make certain that the goodwill of the management spirit finds its way into the practical everyday relationships of employees and their work. Realism in action again.

Through every phase of Chrysler operations is evident a practical emphasis on the greater importance of human beings than of materials and machines in the manufacturing scheme. "When any tool, machine or other piece of equipment **IS NOT SAFE AND NOT IN WORKING ORDER, DO NOT USE IT** until it works properly", commands *Chrysler Safety Rules* near the top of its opening page.

"Our foremen are urged to keep the principle of the square deal ever foremost in their minds. Their working definition of a square deal is to give and receive value for value." So says a memorandum descriptive of Chrysler's ever-growing foreman training activities. But of tremendous practical operating significance is the sentence which follows: "The success of a foreman in interpreting and administering this principle is reflected in his departmental morale." That means that the management actually places the burden of proof on its own representatives—the foremen. Realism!

The force which polices Chrysler's vast plant acreage—Plant Protection Department, it is called—is operated primarily as a service organization to employees and visitors as well as to the management itself. "Courtesy toward all whom they contact is an absolute requirement of Plant Protection men . . . The least that a Plant Protection man can do is to be pleasant . . . Employees naturally look to Plant Protection men as sources of information. Supplying such information is both a duty and an opportunity as it is the best type of contact with the employees." Thus reads the Chrysler *Manual of Plant Protection.* Here again pleasant and fair personal contact is clearly something that management expects of the individual as a part of his job—and a training course is provided to back up the instructions.

"Dept. 10²—A" brings no sentimental thoughts to mind as one reads the lettering. There is nothing sentimental about its operation, for that matter. But it does spell financial safety and self respect to scores of Chrysler employees whose efficiency has been impaired by age or who have become partially incapacitated. It was established to provide employment for such Chrysler workers and to it is routed light work of a miscellaneous nature. When employees of this department become totally incapacitated, they are cared for under the Corporation's Mutual Benefit Division of the Chrysler Industrial Association.

In the two-year apprenticeship training course, preference is given in selection of applicants to sons of Chrysler employees, if other qualifications are equal.

When some employees brought up the question a year or so ago about day-rates as opposed to group piece work wage payments, Chrysler simply put the question up to the employees in the departments involved. These voted in favor of the day-rate wage plan. Now practically all employees

***Above*—"Dept. 102-A" spells financial safety and self respect to scores of Chrysler employees whose efficiency has been impaired by age or who have become partially incapacitated. *Left*—"Courtesy is an absolute requirement of Plant Protection men," says a Chrysler manual for its factory police force—but a practical training course supplements the formal instructions**

except those in the forge plants are paid on a day-rate basis.

Examples could be multiplied indefinitely from every part of the Chrysler operation. They would serve only to make more emphatic the obvious conclusion that fair play and consideration for individuals as human beings is routine at Chrysler. It doesn't make as good a story as some of the much publicized "systems" and "golden-rule" operations of the past; but it does make Chrysler a good outfit to be working for and a good place for the average worker. He doesn't get much rhetoric, but he gets realistic consideration of his practical necessities and desires as an individual worker.

At every turn, moreover, one finds clear evidence that all of these Chrysler policies are meant to be used—not just to be talked about.

Ninety-five per cent of Chrysler foremen are enrolled in a practical training course which takes two years to complete. When they finish this once-a-week training, they carry on for two more years on a once-every-two-weeks basis. After that their education continues with meetings once a month. As in every industrial plant, the foremen are recognized as the key men in practical interpretation of management policies in every day work. Here at Chrysler they are not only schooled in company policy, but also in specific methods for carrying out that policy in practice.

Over half of the assistant foremen already have been enrolled in these training courses and the group leaders below them are being brought under instruction at a more rapid rate each year.

The employee representation plan at Chrysler is recognized by the management as being a method of improving contact between men and management. "Collective bargaining," says Herman Weckler, Chrysler's Industrial Relations Supervisor, "is a meeting of minds rather than a counting of ballots. Any plan will fail if management does not mean to be fair—and vice versa."

Consequently the management representatives on the Chrysler works councils have tried to be actively fair rather than merely negatively honest in their functioning with the employee representatives ever since the plan went into effect three years ago.

That the employees believe the plan to be practical is best indicated by the fact that an overwhelming majority of them continue to be interested in its workings and to vote in the annual elections. About 95 per cent of the Chrysler workers eligible voted in the 1936 employee representative election.

Each month the joint committee meets. This joint meeting is preceded by a separate meeting of employee representatives from which topics to be discussed at the joint meeting are sent for study to the management representatives who also gather separately prior to the joint session.

The recently established laboratory of industrial hygiene is another evidence of Chrysler determination to be realistic in application of its human relations policies. Inaugurated in addition to one of the most complete and effective plant medical operations in American industry, this new division studies occupational diseases and their sources, together with working conditions leading to industrial health hazards. It envelops the usual sanitation efforts as merely one division of its more fundamental activities. Its roots lie in preventive medicine. Its branches include toxicology, applied physiology, chemical, mechanical and ventilating engineering.

New materials and new manufacturing methods are submitted to this laboratory for analysis and approval from a health standpoint before being incorporated into production routine. This department is equipped to make quantitative determinations representing actual conditions of workman exposure and to compare results with known safe exposures.

The management thinking behind the whole vast structure of Chrysler medical work is simple in its essence. It is well summarized by K. T. Keller's answer to a recent question. "Why are you going to all the trouble and expense of air-conditioning your foundries?" Keller was asked. His brief reply spoke volumes. It was:

"Wouldn't *you* rather work in an air-conditioned foundry?"

Safety work at Chrysler is a further manifestation of the spirit of practicality in industrial relationships. Constantly emphasized, carefully studied and persistently applied, the efforts of the plant safety division have made Chrysler definitely a better-than-average plant in which to work from a safety standpoint. Accident frequency at Chrysler was well below that of the average for 65 of Detroit's leading plants in every month of 1935.

Just now Chrysler is in process of developing its apprentice training activities. One hundred boys, each of whom has completed a high school course, are being trained for a variety of work in the Chrysler plants. Their instruction is on an educational basis, although they are paid an average of 50 cents an hour during their two-year training regime. The aim of the course is to give a well rounded training to make the boys available for work in almost any department. Development of journeymen is not being attempted.

The widespread operations of the Chrysler Industrial Association, an employee operated organization, well symbolize and summarize the cordial group consciousness which Chrysler methods seem to have brought about.

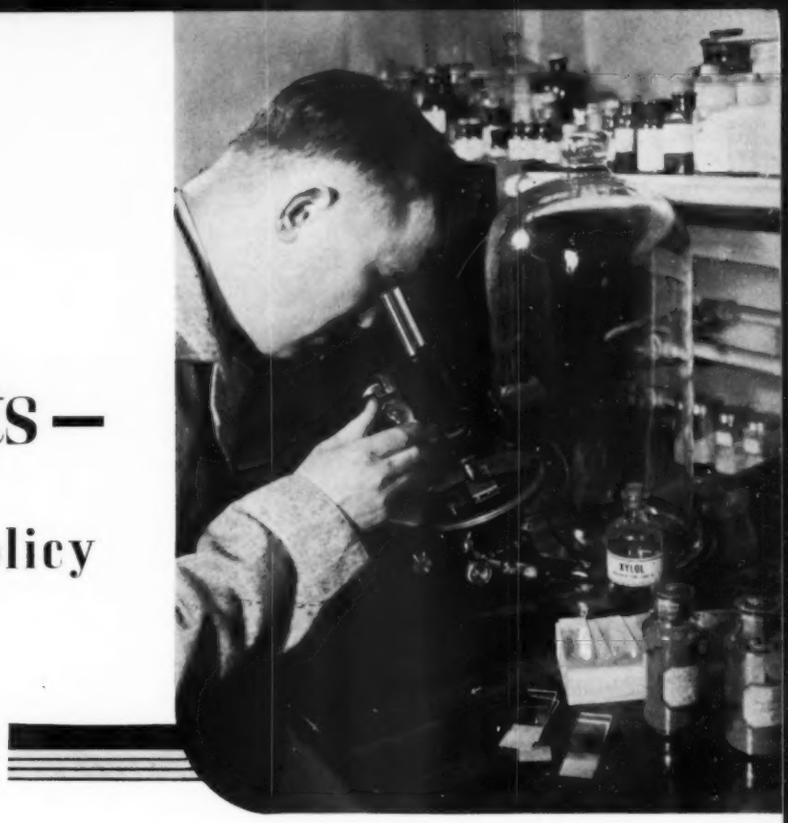
More than 95 per cent of Chrysler employees are members. CIA activities cover athletic and entertainment features, sick benefits, insurance and cooperative stores, the profits from whose sales are devoted to the other objects of the association.

This CIA does things. It has $143,000,000 of life insurance in force, averaging about $3,000 a policy. Since 1929 it has paid over $3,000,000 in death claims; some $2,000,000 in sick and accident claims; and three-quarters of a million in total disability claims under its mutual benefit division. Sales in its stores—which require 60 employees—last year grossed $388,000. Its vending machines in 1935 sold over 1,000,000 candy bars and over 2,000,000 sticks of gum. Over 9,000 of Chrysler employees are engaged in some form of athletics under Chrysler auspices.

Two hundred male voices make up the Chrysler Choir, an employee-generated organization, whose fame has spread through frequent concert appearances and through radio and phonograph recordings

Production to Precise Limits—

a Basic Policy



THE RAPID RISE of Chrysler Corporation is no accident. Anyone interested in examining the reasons why it has been so successful in so short a time will discover many contributing factors—the type of men in charge of its management, its loyal group of employees, its spirit of youthful enthusiasm, its extensive retail distributing organization, the quality of its products and its manufacturing skill. No matter what the price of its cars, all are built with the same precision of workmanship.

Chrysler's management has always believed that the same precision should go into the building of a $550 car as into a $1,200 car. One car may be of shorter wheelbase, less weight and power, and smaller number of cylinders than another, but its parts are made to just as close tolerances and fit together as perfectly. That is why the visitor to the Plymouth plant will see just as many operations calling for limits measured in thousandths of an inch as in the Chrysler, De Soto and Dodge factories, where higher-price models are made.

One should remember, too, that what is called precision today is something entirely different from the precision of ten years ago. Machine tools now are built to do much finer work than formerly, and inspection devices have been invented which permit accurate and quick checking of production parts. Where certain parts used to be tested by having one out of every one hundred along a production line inspected, today every part coming off the line must pass inspection. If it doesn't—and the inspectors are pretty fussy—back it goes for correction or scrap.

A prominent production executive has said, "If you pick the right machine and build the tools for it in the right way and have the proper sequence of operations in the manufacture of a product, you are bound to get an exact duplicate of the product every time a unit is made. That in itself is precision workmanship and is what every manufacturing organization should aim at." Chrysler has not only aimed at it, but also attained it.

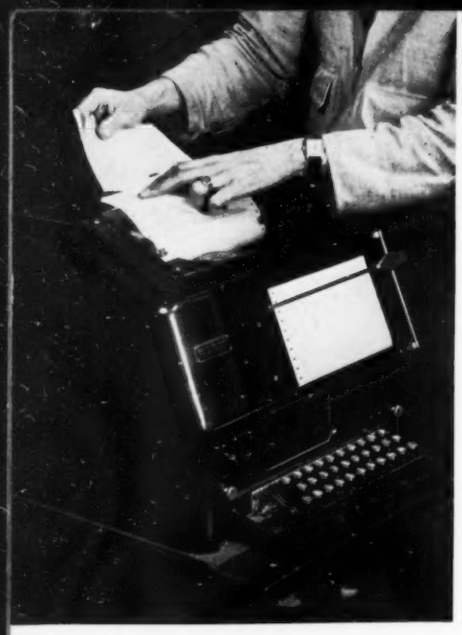
Close inspection is found in every department of the Chrysler organization. Inspection is completely divorced from manufacture. The inspection department is directly under the operating manager of each plant and reports only to him. It is not influenced by any tie-up with production departments, and can be impartial in its work.

Precision workmanship is not confined to machining departments and other manufacturing departments where one normally would expect to find it. It has spread into the forge shop and the foundry. Much time and effort have been expended by forge shop officials to make forgings to closer limits. A notable example of their success is the connecting rod, on which much less machining has to be done than formerly. In other words, greater precision in the manufacturing routine actually is resulting in a better product at lower costs.

The same story is discovered in the foundry. Jigs and fixtures heretofore used only in the machine shop are now a part of the regular equipment of the Chrysler foundry. Core making has been put on a scientific basis by means of special core-blowing equipment and ingenious fixtures. In the core-making process, tolerances have been reduced to a point never before attempted in gray iron foundry practice. And the management testifies that this sort of precision pays, because it has reduced foundry scrap losses to an unbelievably low figure.

What will amaze the visitor to any Chrysler factory is the adoption in mass production of a degree of accuracy which he probably associates only with the laboratory. To illustrate the point—at the Plymouth plant around 18,000 pistons a day are machined so that the wrist pin bore of each piston is held within two ten-thousandths of an inch. Cylinder bores are explored and graded with Electrolimit visual gages which indicate the precise grade for each bore. The operator uses a hand tool with a pistol grip, the measuring device and grade meter being located at a remote point but connected electrically with the gaging head. The gage gives not only the grade, showing the diameter of the bore, but also can be used for taper and out-of-roundness.

But, after all, it isn't the visual evidence on all sides of a thorough checking of every part before it goes into the car and then another checking of the car after assembly which gives a true picture of Chrysler's adherence to precision workmanship. It is the day-by-day performance of each repetitive operation on all kinds of machine tools within limits which seem impossible, but have been achieved by men who refuse to build anything but the best.



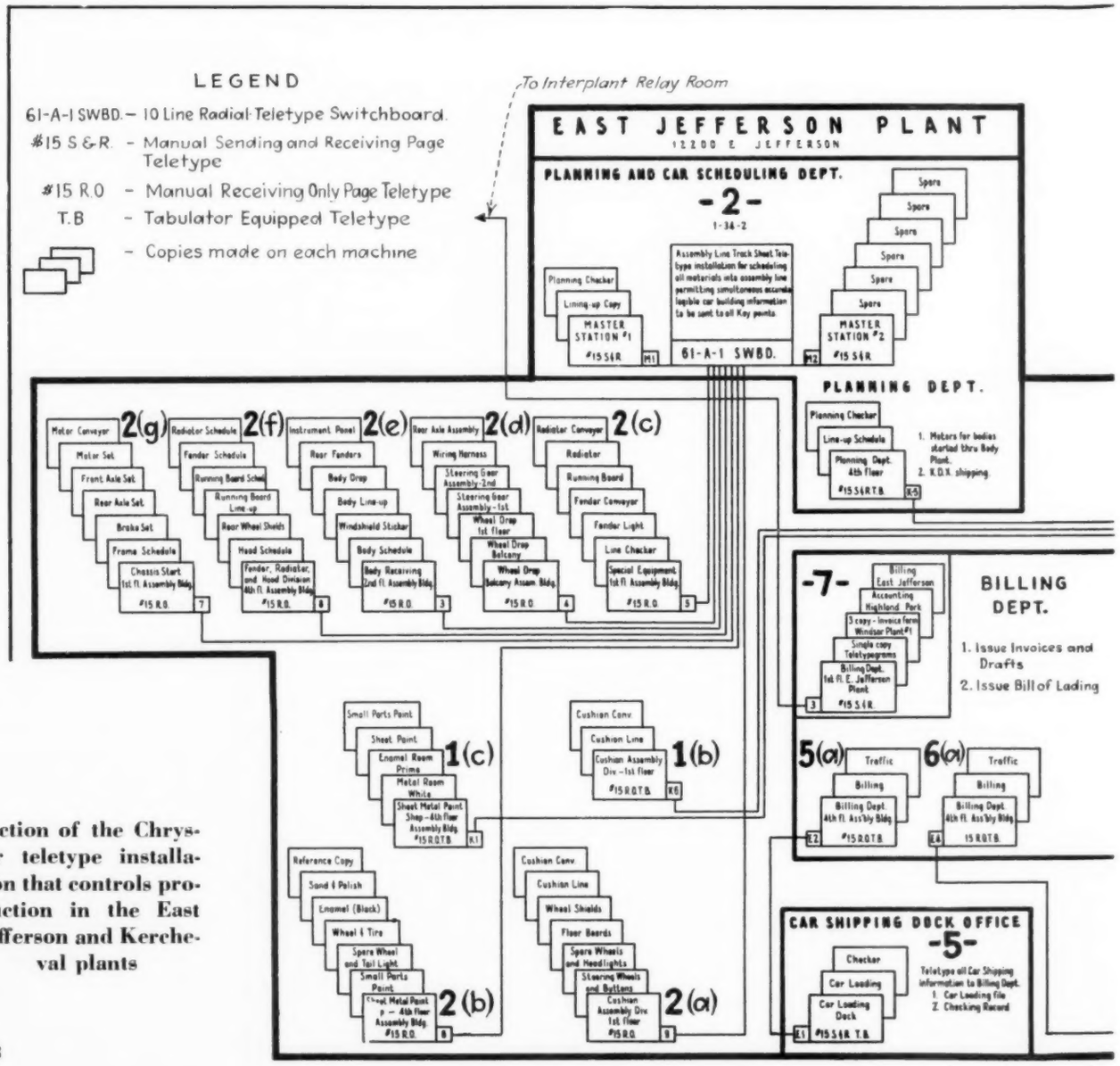
A teletype receiving machine reproduces several copies of the message typed on the sending station instrument

The Time, the Place

A teletype installation reduces delay in assembling the various parts of widely different body, chassis and color combinations

SPEED IS a major requisite in the set-up to inform departments what they are expected to turn out. There can be no lag on the part of any operation or the synchronization of production will be seriously disturbed. Aware of this fact, the management of the Chrysler Corporation has installed teletype systems in its chief manufacturing divisions. The most elaborate system is at the Jefferson and Kercheval plants in Detroit.

This installation consists of seven sending stations and 18 receiving sta-



Section of the Chrysler teletype installation that controls production in the East Jefferson and Kercheval plants

and the Unit...

tions. The first sending station *(1)* is on the first floor of the Kercheval body plant. As bodies in the white are produced, pertinent information regarding further processing is teletyped to sub-stations throughout the plant. The cutting and sewing department *(1a)* receives instructions, thus assuring the proper material being available when the body reaches the trim shop.

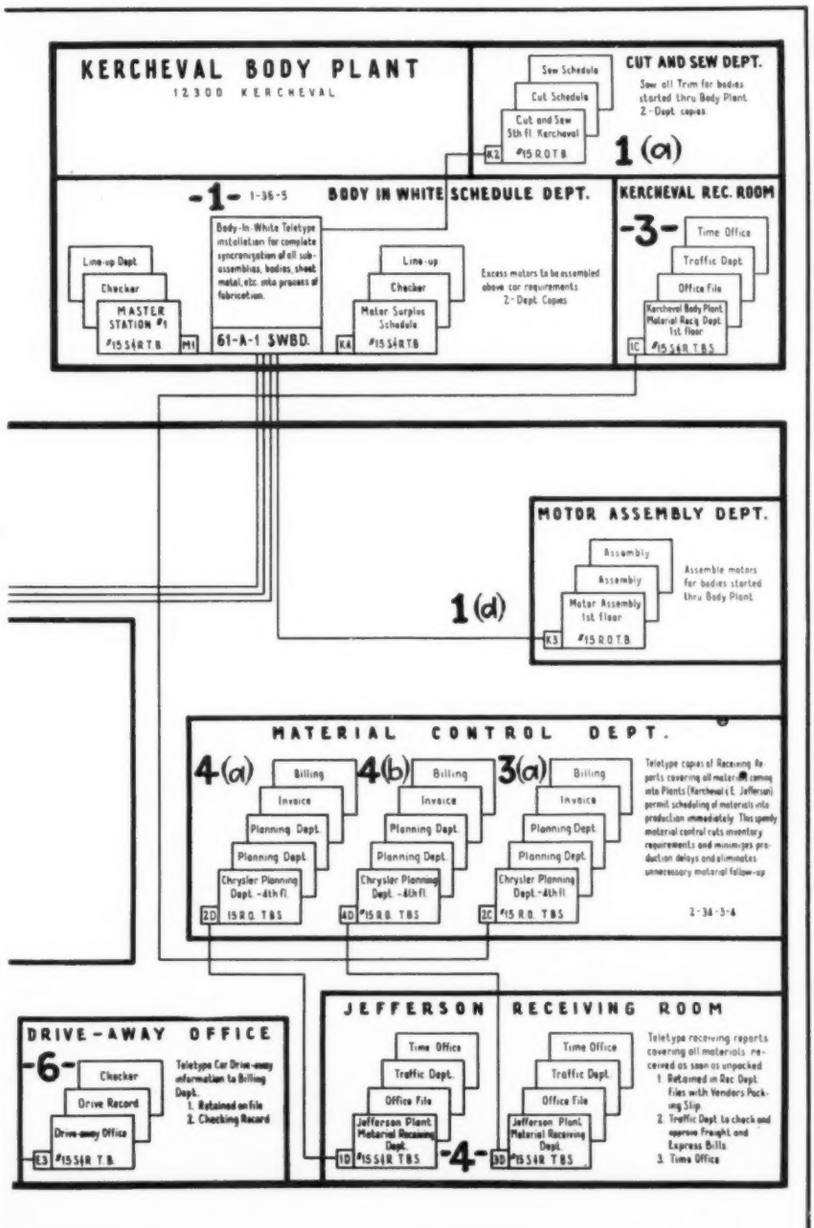
The cushion and back department *(1b)* at the Jefferson Avenue plant across the street is given data by teletype about the bodies to be built. The sheet metal paint departments *(1c)* at Jefferson starts to paint the sheet steel parts for the designated bodies as word comes over the teletype. This arrangement makes it unnecessary to carry large banks of various colors. Motors *(1d)* are started on their way to the final assembly line.

As finished bodies are received, the planning department at the Jefferson plant gets a track sheet line-up and teletypes instructions from its sending station *(2)* to seven receiving stations *(2a-g)*, from which the information regarding details of how cars are to be built is distributed to all departments involved (numbering 42). Sub-assemblies then are started and parts are placed on conveyors or on the assembly line in the sequence shown on the track sheet. They arrive at the assembly point in the proper order and at the right time.

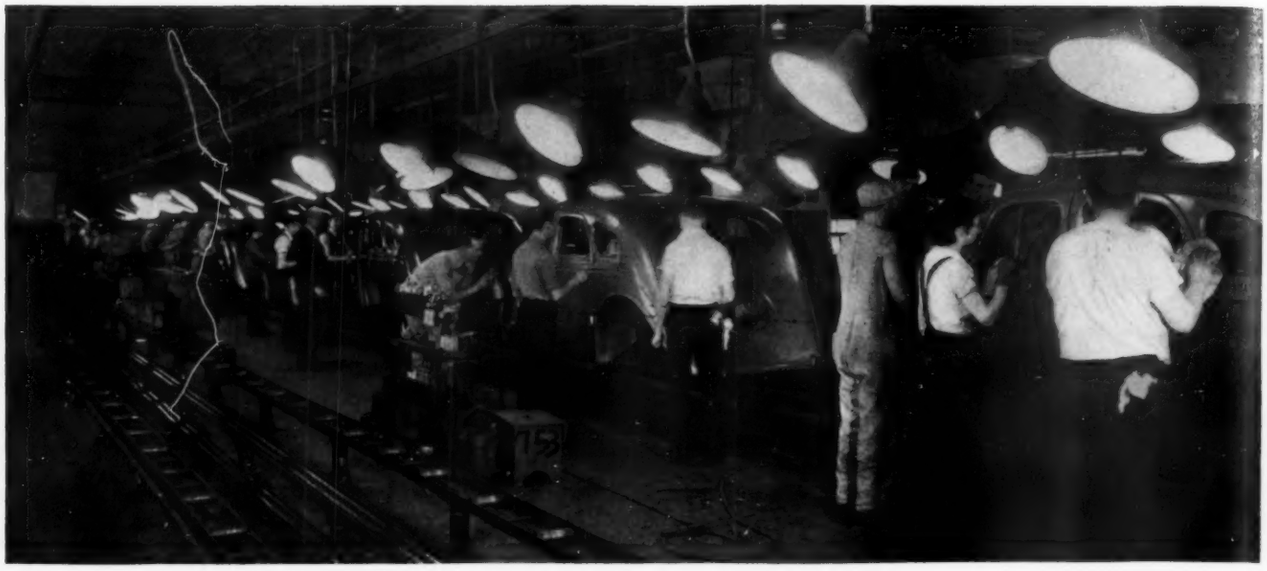
Third and fourth sending stations *(3* and *4)* are located in the receiving rooms at the two plants. Information about all material coming into each plant is teletyped on special forms to the planning department. Four copies are made, two for the use of the accounting department and two for the planning department. This means that a description of incoming materials is available within a few minutes after it is received.

The fifth and sixth sending stations *(5* and *6)* are at the car shipping dock and at the drive-away office. As soon as a freight car containing finished automobiles to be shipped to dealers is sealed, the information necessary for the invoicing, and issuing drafts and bills of lading, is teletyped to the accounting department. This system provides a uniform flow of work to the accounting and traffic departments, with practically all automobiles being invoiced the day they are shipped. The same system is followed in connection with drive-aways. There is a saving of three to six hours compared with the former system.

In the billing department at Jefferson Avenue is the seventh sending station *(7)*. It is connected with the Canadian customs office, resulting in speedy transmission of Canadian invoices and enabling quick clearance of shipments to the Canadian plant. It saves many truck hours which otherwise would be wasted waiting for the necessary billing information.


KERCHEVAL BODY PLANT
12300 KERCHEVAL
Saw Schedule
Cut Schedule
Cut and Saw 5th fl. Kercheval
K2 #15 R.O.T.B.
CUT AND SEW DEPT.
Saw all Trim for bodies started thru Body Plant.
2 - Dept. copies
1 (a)
-1- 1-36-5
BODY IN WHITE SCHEDULE DEPT.
KERCHEVAL REC. ROOM
Line-up Dept.
Checker
MASTER STATION #1
#15 S&R T.B.
M1
Body-In-White Teletype installation for complete synchronization of all sub-assemblies, bodies, sheet metal, etc. into process of fabrication.
61-A-1 SWBD.
Line-up
Checker
Motor Surplus Schedule
K4 #15 S&R T.B.
Excess motors to be assembled above car requirements
2 - Dept. Copies
-3-
Time Office
Traffic Dept.
Office File
Kercheval Body Plant Material Recv. Dept. 1st floor
1C #15 S&R T.B.S.
MOTOR ASSEMBLY DEPT.
Assembly
Assembly
Motor Assembly 1st floor
K3 #15 R.O.T.B.
Assemble motors for bodies started thru Body Plant
1 (d)
MATERIAL CONTROL DEPT.
4 (a)
4 (b)
3 (a)
Billing
Invoice
Planning Dept.
Planning Dept.
Chrysler Planning Dept. - 4th fl.
2D #15 R.O. T.B.S.
4D #15 R.O. T.B.S.
2C #15 R.O. T.B.S.
Teletype copies of Receiving Reports covering all motors coming into Plants (Kercheval & Jefferson) permit scheduling of materials into production immediately. This speedy material control cuts inventory requirements and minimizes production delays and eliminates unnecessary material follow-up
2 - 3A - 3 - 4
DRIVE-AWAY OFFICE
-6-
Checker
Drive Record
Drive-away Office
E3 #15 S&R T.B.
Teletype Car Drive-away information to Billing Dept.
1. Retained on file
2. Checking Record
JEFFERSON RECEIVING ROOM
Time Office
Traffic Dept.
Office File
Jefferson Plant Material Receiving Dept.
1D #15 S&R T.B.S.
-4-
3D #15 S&R T.B.S.
Teletype receiving reports covering all materials received as soon as unpacked
1. Retained in Rec. Dept. files with Vendors Packing Slip
2. Traffic Dept. to check and approve Freight and Express Bills
3. Time Office

Operator typing assembly line track sheet which is recorded simultaneously at receiving stations in the departments interested



Safety, Comfort and Efficiency

Ten rules to insure a department layout that will make a shop a good place to work in

IF A COMPANY is to have an efficient manufacturing plant, it must be able to make a quality product and to make the product at the right price to sell in large volume. To do this the plant arrangement must be good; the closer the management gets it to perfect, the better the results will be.

Chrysler has taken these points into consideration in arranging the production line-up in its many plants. Some of the cardinal rules which it has observed are on the opposite page.

In laying out its plants, Chrysler has gathered in one spot all cast iron machining departments, and in another spot all steel parts, which must have coolants in connection with machining. When it comes to assembly of parts, the problem bobs up of how much sub-assembly work can be put along the line and how much must be fed up to it.

Any automobile company which continues to grow and doesn't regularly spend money for factory rearrangement is heading into trouble. Chrysler makes a substantial yearly outlay for that purpose. Manufacturing changes are made only after the most careful study. Sometimes this involves the moving of entire departments, and in other cases it means only the shifting of equipment.

At the beginning of a season the central estimating department sends out requests for cost quotations (labor only) on machining parts to several of the corporation's plants. It is always possible that some one plant may have a set-up which is more economical. On the other hand, it is not the practice to give a job necessarily to the plant with the lowest machining cost, because other factors, such as expense of transportation of materials from one plant to another, enter in.

Getting a factory or department ready for a new production job is a big task. After the design of a part is determined, the tool routing men list all of the existing equipment available for production of the part and how much the job will cost when tooled up. In an adjoining column is listed the highest powered production line and what the purchase of machine tools for it would cost. In a third column is set down a compromise utilizing the best of the existing machinery supplemented by some new machinery. Final recommendation is made by the general master mechanic of the corporation, the operating manager of the plant and the plant's master mechanic.

The master mechanic turns the approved plant line-up over to the plant engineer who lays it out as a production line according to the operation sheets. The time-study man then goes over the line-up and shows where some change in operations can be made to attain the most economical production. For example, it often is possible to drill certain holes in a cast iron part either preceding or following other operations. Finally the master mechanic prepares

Combined

1. It must be easy to feed the raw materials to the production line.

2. It must be easy to move parts away from the production line.

3. Equipment must be so arranged that chips can be removed without difficulty while the plant is operating.

4. There must be sufficient space for operators to work with comfort and safety.

5. Machines must be installed so that operators can do their work in a natural position rather than in cramped fashion.

6. Factories must be kept clean.

7. There must be enough space ahead of the production line to store a bank of materials.

8. Work must move in a straight line without backtracking.

9. The layout must be such that it is easy to supervise.

10. The department must be properly lighted.

the routing of operations to be followed in actual production.

One problem intimately connected with efficient plant layout is that of routing conveyors of various types. Chrysler uses overhead conveyors in its plants mostly for the carrying of materials to and from production lines and through operations such as automatic plating and enameling. Such conveyors transport whatever bank of materials is necessary between the points of finishing and assembling, cutting down handling expense and preventing marring of polished surfaces.

A tendency in some plants but avoided in the Chrysler factories is to try to put everything on a conveyor to be moved. The trouble in doing this is that when a part is changed in design, the management is faced with a substantial expense because the conveyors aren't of the correct type or must be moved about to accommodate the new operations.

Plant layout is tied up with the quality and uniformity of parts manufactured. To cite an example of what happens when plant layout isn't taken into consideration: a transmission gear may be perfectly machined, but ruined in heat treatment. The forge shop might not have checked the steel to see that it was up to specifications or the forging die was so constructed that it did not give the right grain flow or the normalizing itself was not correct. There must be a good set-up for handling the gear and perfect control of the furnaces must be maintained, for no matter how well the gear checks to dimensions, it lacks quality unless it is of the right hardness.

The best way to insure uniformly good quality of products, therefore, is to have a proper layout so that work flows along a given line and is not heat treated in one furnace today and another tomorrow. Chrysler plants have such layouts.

Chrysler stresses the fact that operators must be given sufficient room in which to do their work. This is particularly true in screw machine departments or on any machine which has horizontal moving members.

Cleanliness of the plant has much to do with keeping employees satisfied and also makes it possible to have a better class of men on jobs, which is a help to quality of the product.

Long experience has convinced the Chrysler management that to achieve economical costs and high quality it must have a design which permits of economical and accurate manufacturing, a tool and machine line-up that is practically fool-proof, a correct factory layout, and that it must make a close check on specifications of incoming and outgoing materials. Chrysler realizes that, after all, quality is not something that can be entirely measured in thousandths of an inch but rather by the service the product gives to the customer.

Materials from 1400 Suppliers—

Their Selection and Control

Random samples are tested by the laboratory as a routine job. Other purchased parts are tested on request of inspectors

NOWHERE is greater care taken in selecting materials and controlling their proper use than in Chrysler Corporation. Upon the scientific handling of this matter depends the economical purchase of materials and parts combined with the necessary quality which the management insists must go into every Chrysler-made car.

The Chrysler purchasing department is charged with the responsibility for buying all materials for four lines of passenger cars, involving 61 body types, a line of trucks with 34 chassis models, each one of which has five or six body types, for marine and industrial engines, for air conditioning equipment, and for various other Chrysler products. Single orders run from a few cents to millions of dollars.

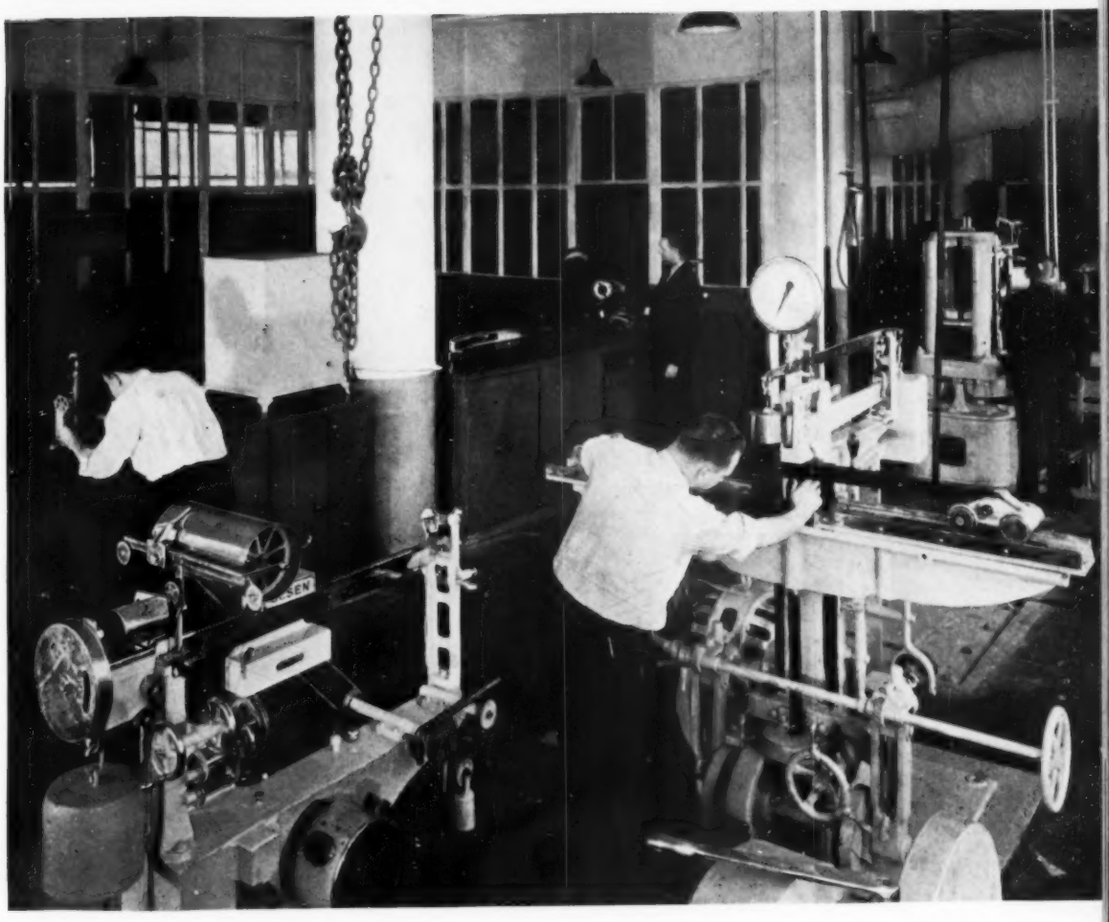
There are some fourteen hundred different suppliers who furnish the thousands of items for these automobiles. The purchasing department's records reveal that buying is not restricted to such things as steering wheels, tires, shatter-proof glass, steel and upholstering fabrics, but extends to products carried by the dime store, the corner market, the drug store and the dry goods dealer.

Proper selection of materials ties the purchasing and metallurgical departments closely together. All parts made by vendors are tested in the metallurgical laboratory. To give a brief account of one day's activities—each morning a representative of the metallurgical department makes a trip through each Chrysler plant, contacting department heads on the way. He consults with the receiving and inspection officials as to what parts shall be sent to the laboratory to be tested in addition to the regular daily list consisting of from two hundred to four hundred samples picked at random from shipments as they come in. Materials and parts tested include those produced in Chrysler plants, as well as those purchased. Some of the samples thus secured are analyzed chemically and others are cut up and examined under the microscope to see if they have been properly heat treated.

Heat-treated parts are given a hardness test or other physical test to see that they are within specified requirements. Plated parts are put in a salt spray or are cut up for microscopic examination for depth of plating, or must go through both tests. Rear axle drive-shafts are placed in a torque testing machine and twisted until they fail and the number of thousands of inch-pounds necessary to failure recorded. Fly wheels are mounted on a centrigual machine, put in a pit, and the speed brought up to a point where the wheels burst due to centrifugal force. All parts coming in from vendors are tested.

The metallurgical department sees every drawing of every part before it goes out from the engineering department. If the part happens to be a steering gear knuckle pivot, the drawing carries the number indicating the steel to be used and the number identifying the heat treatment, both of which have been determined by the metallurgical department. It likewise specifies the processing work as well as the material standards. If the part is to be plated or coated, that fact also is covered by a standard specification. All of these standards are set by the metallurgical department. In addition an operation sheet is issued for each heat-treated part, carrying detailed instructions about the heat treatment and inspection.

Selection of the type of steel for a particular car part is an important matter. To be specific, a steering gear knuckle pivot pin must resist wear and at the same time possess shock and fatigue resistance to a high degree. These requirements are best met by a carburized and hardened alloy steel. Chrysler adheres to the policy of choosing the steel for the part rather than adapting the design of the part to make use of certain steels.



In the testing laboratory shown above are many special testing devices for proving materials and parts. Conventional testing machines are in constant use in the other laboratory illustrated

A specific steel may not be chosen solely because of its ability to stand up all right in service, but also because it meets a manufacturing requirement. That is, where each of five steels meet service specifications, the steel which is the cheapest in price isn't always selected. Instead preference often is shown for the steel which can be so fabricated that the cost of the finished part is least.

In certain cases, the adaptability of materials to various smart-looking designs and to economical manufacturing practices is a determining factor. Die cast radiator grilles are an excellent illustration of this point. In comparison with the stamped grille, a die-cast grille, being in one piece, lends itself better to many attractive designs.

Chrysler takes the recommendations of its metallurgical laboratory and builds up experimental parts. Such parts are given accelerated break-down tests simulating car performance. Thus a mechanical laboratory is attached to the engineering division. It is a separate unit which checks recommendations of the metallurgists and of the design department and surveys the results of dynamometer and road tests.

The test period for any new material or process before a final decision is made is extended to an actual tryout in production. Costs are established and the manufacturing division becomes acquainted with the material or process before being asked to swing into 100 per cent production with it. This policy is of particular advantage when the change involves new equipment or a radical change in the sequence of operations.

To determine material best fitted and most economical for its requirements, to reduce inventories to the lowest practical minimum by cutting down the number of varieties, to develop interchangeability of materials between plants and to help establish dependable sources, Chrysler maintains a non-productive material standards department located at the Dodge main plant and under the supervision of the staff master mechanic. This department provides for proper tests to find out the relative merits of new or improved material not being purchased as compared with material in use.

All non-productive materials are standardized which involve (a) usage in volume or in several departments in Chrysler plants, (b) specifications peculiar to Chrysler requirements, and (c) the necessity for definite specifications for purchasing purposes. Standards may be requested on particular items by the department interested, by the plant management or by the purchasing department.

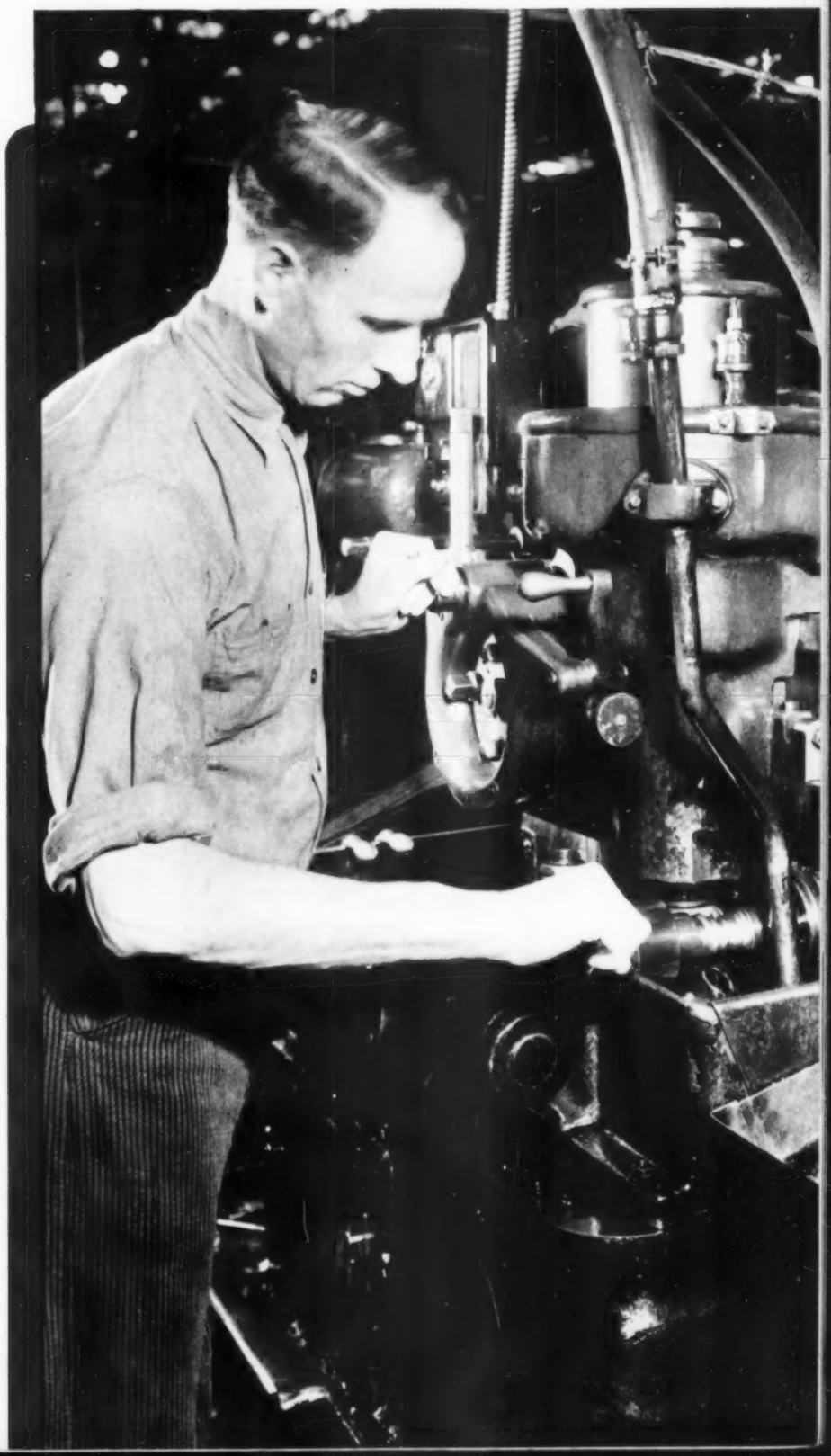
Standards and approved sources of non-productive materials in general use are determined by studies of Chrysler's requirements and surveys of the corporation's experiences with the materials being used and the relative qualities of those supplied by various vendors. Laboratory tests and special operating tests are made, when necessary, to determine the approved analysis, performance, and other required specifications, and to decide the vendors whose products meet such specifications. Such tests and surveys are conducted in the various plants in cooperation with the standards department. From these reports the standards department establishes and issues non-productive material standards. These standards give the specifications required in a satisfactory product, such as physical analysis, performance, purpose for which it is required, and dimensions.

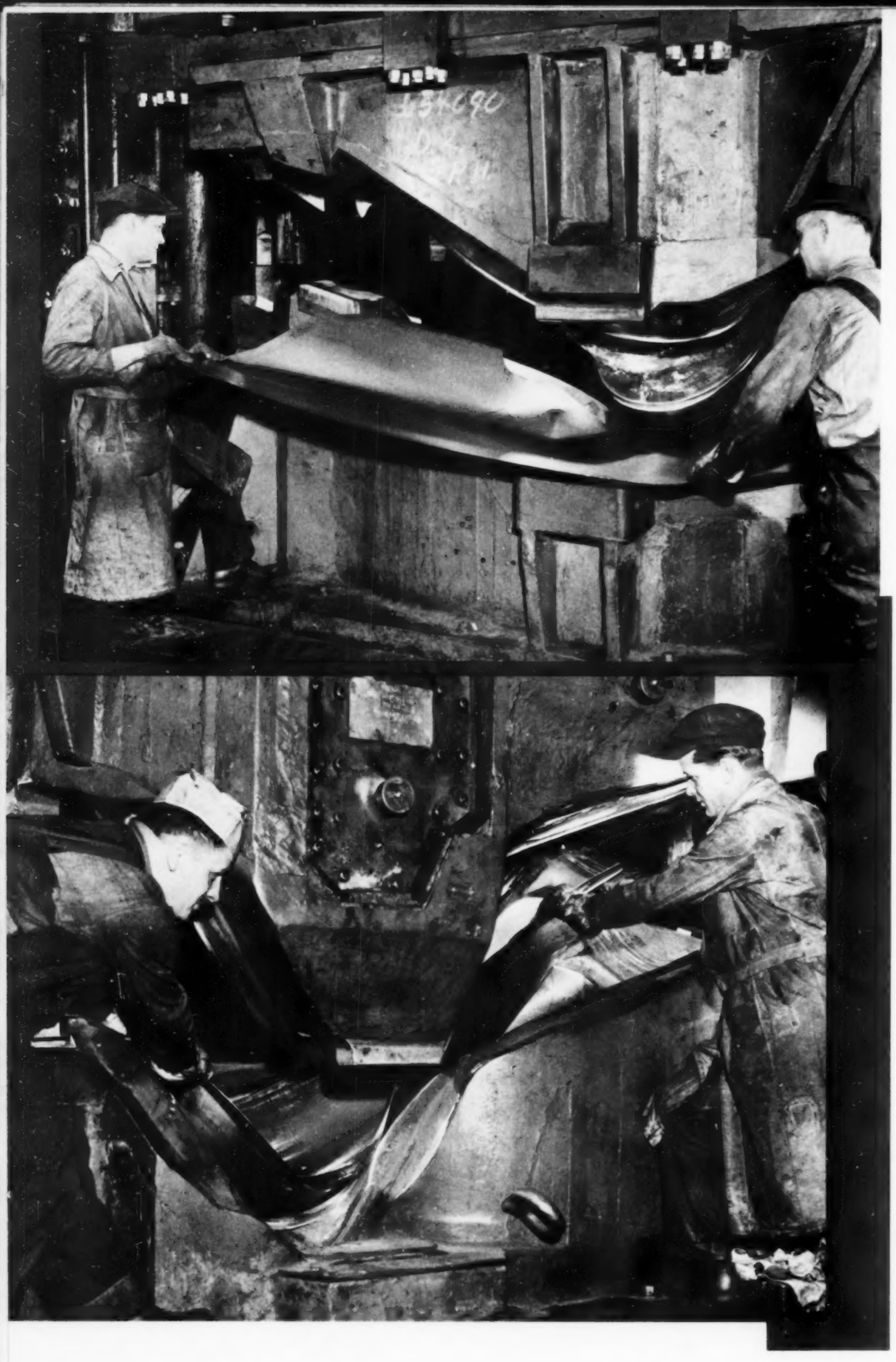
Whenever it may be desirable to determine the merits of products of another source with the materials being used, the purchasing department contacts the new source. When the purchasing department wishes tests made, it sends the vendor to the standards department which arranges with the plants and laboratories for running the test and makes a report of results and recommendations to the purchasing department.

Should a plant wish to order material differing from the standards for special test, a letter is attached to the purchase requisition explaining the purpose of the desired test. The requisition and letter then go to the standards department. If previous tests have been made with the same material, the department advises the plant requesting the material regarding the result of the test and decides whether further tests are needed. If no previous tests have been made, or further tests are deemed advisable, the department approves the requisition for a sufficient quantity of material to make the test and forwards it to the purchasing department. The plant making the test then reports the results to the standards department which considers the advisability of changing the standards.

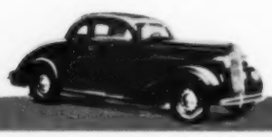
Fabrics are tested in this special machine which gives the equivalent of three years' wear in a day or two

Production Methods





It goes in sheet steel and comes out a fender; the double cam die forms a complex contour at a single stroke of the press



One part instead of many — wind-shield opening, door posts, top and sides of the cowl were formerly separate stampings, but progress in press work has reduced them to a single unit

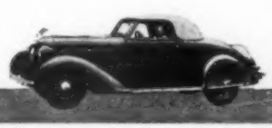
Streamlined Contours Stamped Out

Car beauty owes much to ingenious die design as exemplified by the press set-up on the one-piece front fender

CHRYSLER stamping departments reflect a great deal of skill in getting the best out of sheet steel. Stamping an individual part is in itself a short operation, but the care with which this is done greatly affects subsequent operations and the resulting cost of the piece. If a fender or body panel carries any irregularities on leaving the press, these must be entirely removed and the part hand polished until it is certain that the marks will not carry through to the finished work after the lacquer has been applied. Finishing in the paint shop does not hide these defects. In the Chrysler plants the effort has been to produce sound, clean stampings; careful attention is given to die design so the subsequent handling and corrective operations will be reduced to a minimum.

One interesting operation is the forming of passengers car front fenders. Because of the deep curve of this part in following the contour of the wheel, its concavity is such that the forming punch will not withdraw from it in any single direction. Some makers have attempted to overcome this difficulty by making the fenders in two pieces and welding them together. This method gives satisfactory results, but the fact remains that there are two stampings to be made in addition to the expense of welding and grinding away the flash to obtain a surface smooth enough to meet the requirements for finish.

The Chrysler plants follow a different method; front fenders are made in one piece. In order to do this, the forming punch must first move downward against the stock, pressing it into the die and then move diagonally sidewise into an undercut portion of the die



to give the correct contour. To secure the desired motion a double tapered cam is required. The loose portion of the punch is guided by a slide in the main member in such a manner that after the bottom of the stroke is reached the punch slide of the press brings into operation the two wedge-shaped cams. One cam forces the punch segment forward, while the other moves it sidewise to complete the forming action in one stroke. A clean smooth front fender results with no welding flash to be removed to give it a good appearance. Production is 150 an hour.

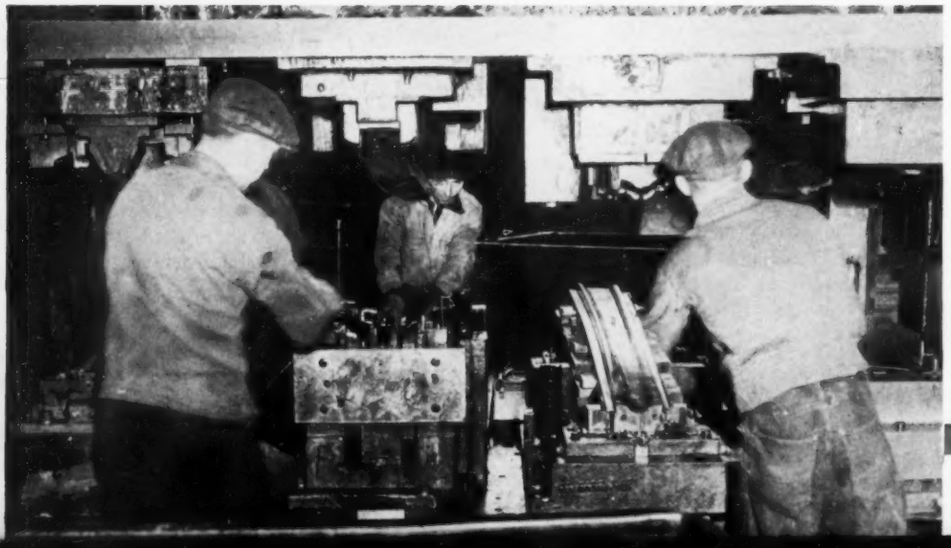
Another excellent example of stamping practice at this plant is the front cowl. This piece includes the windshield opening, the front door posts, and the top and sides of the cowl. It is formed as one stamping in a Toledo press.

The oil pan, another stamped part, requires careful handling because of the heavy stock and deep draw. Formerly such parts were cast, but the pressed steel construction saves weight while adding strength to the pan. The draw is not uniform as the sump at one end must be several inches deeper than the rest of the pan. In order to form a smooth draw, without several press operations and annealings between them, a hydraulic cushion is used in the press bed. This enables the first draw to be made uniformly, and then, as the pressure increases, permits the sump to be drawn in what amounts to a separate operation, although each piece is completed in one stroke. A heavy tallow is used for lubricant on this job.

Multiple Set-Ups

A practice used for some parts in this plant is to run a series of operations in one press. A good example of this is the side sill finish panel which has four separate stamping operations. A 450-ton hydraulic four-point Clearing press is used with the dies set across the width of the bed so they can be used consecutively; each performs an operation on a pair of panels with each stroke of the press which permits two finished panels to come off at each stroke, or 450 pieces an hour. Sheet steel, 0.035 in. thick, is drawn and pierced in the first die which is arranged with a bead on the edge so the metal will be gripped before the last $\frac{3}{8}$ in. of draw takes place. This design assures the proper degree of stretch to form the panels. The second die splits the piece into right- and left-hand panels, notches the two parts and trims the ends. The third die redraws and forms the flange; the fourth die trims the top flange and cuts the angle at the front end. The advantage of these operations is that one gang of men carries the work through a single press, avoiding the battery of equipment that would otherwise be needed.

At the end of the Dodge press shop a Williams and White straightening roll is installed for salvaging. Large pieces of metal blanked out of windshield openings or other large blanking and trimming operations are sent to these rolls for straightening. The pieces then serve as stock for the smaller parts, resulting in a great saving of metal. This operation is only part of an extensive salvage system extending through all the Chrysler plants.



● Heavy steel stock and a double deep draw made the oil pan problem a tough nut to crack

● Four dies abreast in a single press enable one machine to do the work of a battery on the side sill panel

Where They Hammer Away For Better Forgings

In its nine buildings, the Dodge forge shop houses die, heat-treatment, hammer equipment and maintenance departments

•

MANUFACTURE of forgings is one of the most extensive operations carried on by the Dodge Division of Chrysler Corporation. The Dodge forge shop makes around 100 parts for the corporation's passenger cars and trucks. Its products include brake shoes for all Chrysler models, transmission and differential gear forgings for all its cars, sway eliminators, coil springs for Chrysler and De Soto Airstream models, all connecting rods except Plymouth's, all crankshafts for Dodge and Plymouth and all rear-axle drive shafts for Dodge trucks.

To produce such a variety of forgings, both large and small, this forge division is comprised of nine buildings, including a power house, in Detroit. Six of the buildings are devoted to production and, with a single exception, are approximately 80x500 ft. each in size. There is a large maintenance department and a die shop which makes all forging dies, cold and hot trim dies and blanking and forming dies. Machine repair jobs and other maintenance work are also handled in this shop.

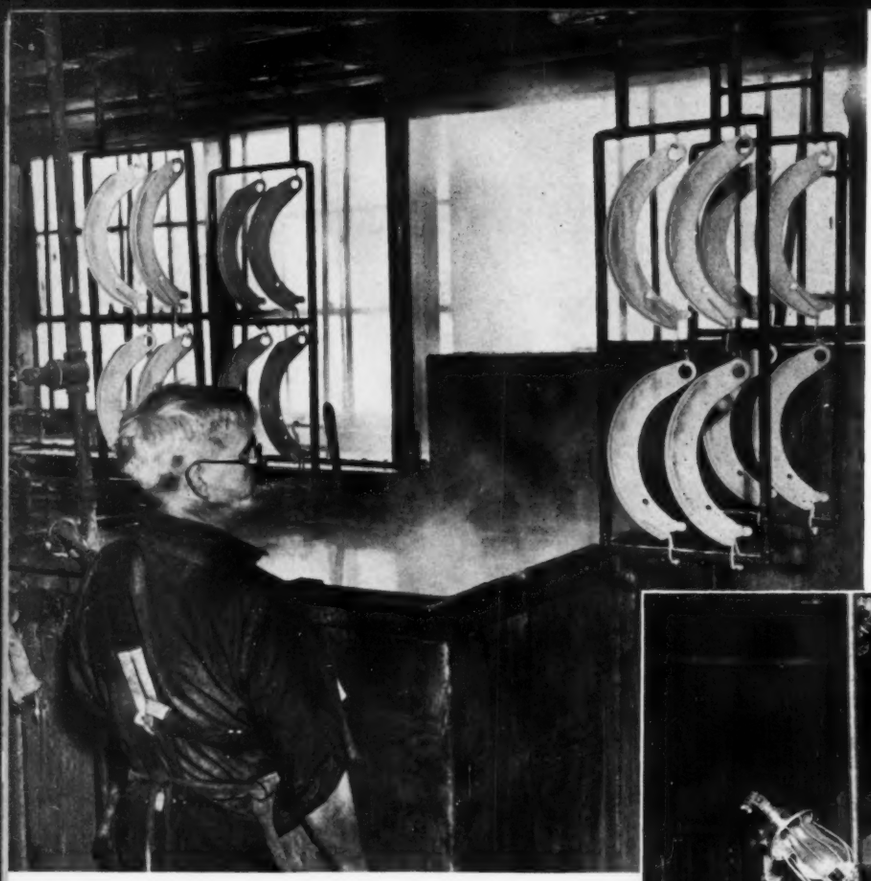
The various buildings are so located in relation to each other as to facilitate the movement of materials among them. Forgings are transported in large steel tote boxes by gas and electric truck from the forge departments to the heat-treating building. After being heat-treated, they are loaded on railroad freight cars on a siding which parallels the heat-treating department for transfer to the car manufacturing divisions of the corporation, or are taken there by motor truck.

The light hammer shop consists of fifteen board hammers, seven upsetters, nineteen steam hammers and two Ajax rolls. The heavy shop has eight board hammers, eleven upsetters, two large coin presses and four 12,000-lb. steam hammers.

One building is devoted to making coil springs and sway bars. The equipment consists of Cincinnati centerless grinders, pointing rolls, coiling machines and all necessary furnaces for heat-treating these parts.

Sides of each forge shop consist of steel doors in every bay above which is glass in steel sash. To assure the most favorable working conditions, heating furnaces have been placed near and facing the sides of the building. The air is drawn through the open doors and pass up to and out the 54-in. ventilators. In winter the doors can be lowered as desired. Each

• A crew of three forges crankshafts in a 12,000-lb. steam hammer



● Suspended from a monorail conveyor, brake shoes are zinc coated to prevent rusting in service

● After forging each crankshaft is Brinell tested in a Gogan direct-reading machine

furnace has a water-cooled front formed of welded steel plates with an opening at the top for the admission of water. After flowing through the front, the water passes to a sump in which all dirt or scale is deposited. The water then is pumped to a larger sump for recirculation to the furnaces. These arrangements contribute to the comfort of workmen.

For production of brake shoes low-carbon steel is purchased in T-bars. It is cut to length, rolled, coined in a coining press, trimmed, pierced and one pivot hole is reamed and burred. At this stage the shoe is placed on a monorail conveyor to be zinc plated to avoid the possibility of rusting in service, especially along the seacoast when exposed to salt air. Each lining and shoe then is drilled, countersunk and riveted to keep the two in line, the riveting being done as the material moves along a belt conveyor. Riveting machines, each with an operator in charge, are located along this conveyor. After riveting, the conveyor takes the brake shoes to inspectors who examine closely each shoe.

Steel for crankshafts is bought in the form of special patented die roll sections from the steel mills. It is heated in a 40-ft. continuous billet heating furnace of the pusher type and is rolled and forged in position in a 12,000-lb. steam drop hammer. The forging is trimmed, the flange formed in a large upsetting machine and the work re-struck. The crankshaft thence is delivered to the heat-treating department, housed in a separate building, where it is normalized, quenched and drawn. Heat-treatment is done in gas-fired furnaces. Crankshafts are deposited in the furnaces by means of a special charging machine operating on rails and resembling in design the apparatus for charging open-hearth steel furnaces.

From the heat-treating department crankshafts are taken to a Gogan Brinell hardness testing machine where each forging is tested. They are inspected for defects, such as scale pits, are rough straightened, centered on a centering machine, finish straightened, balanced and delivered in large metal skid boxes to the machine shop.

Connecting rods for Dodge are forged double from a special patented die roll section bought from commercial steel mills. The forging of two rods simultaneously results in a considerable saving in production costs. After the forging operation, the work is trimmed cold and is sent to heat-treatment. Each rod then is Brinell tested for hardness, re-struck cold to make it straight, coin pressed and then tested 100 per cent for straightness.

Ring gears are forged with the least possible wastage of steel. Four-inch billets are purchased in multiples of

12 ft. with 4 ft. being heated for forging at one time. Gear blanks are forged in a 6-in. National forging machine in a two-stage operation in which the material is formed and pierced off the bar. Fifteen ring gears are obtained per heat.

Gear blanks are taken to a 4,000-lb. Billings & Spencer board hammer and finished forged. The flash is trimmed off and the forging restruck. Forgings then pass to the heat-treating department to be normalized, after which they are pickled and inspected 100 per cent.

In connection with the forge plant, Dodge maintains a completely equipped shop which builds all its forging dies. Equipment in this shop is so diversified that all operations necessary in building the most complicated dies can readily be performed. Machines have been so placed that time is saved and transportation of dies from one operation to the next minimized. Overhead cranes, with a span of 9 ft., give access to every machine bordering the aisles, while monorails pass over the benches and over the machines not served by the cranes. Aisles are wide enough to allow gas and electric trucks to carry complete dies out of the shop to the hammers.

Machine Follows Profile

In the die shop are several machines of uncommon interest because they mark a forward step in machine design. A Cincinnati "Hydro-Tel" vertical milling machine is being operated as a hand die sinker with an automatic tracer mechanism for following a profile. The machine is an entirely new development with features which make it not only especially adapted for die sinking, but also make it available for use as a large vertical miller for surfacing and profiling. The machine illustrates the advantages and possibilities of hydraulics when properly employed in machine-tool design.

It is evident that the heaviest standard planer does not possess the rigidity, strength or power to take the tremendous cuts on modern hard die blocks. To meet this situation Dodge is shanking die blocks on a Gray die-block planer designed to withstand terrific strains. With this planer the full capacity of a 50-hp. motor can efficiently be used to remove metal at a table speed as low as 15 ft. per minute. In fact, this speed has been found most economical, tool life considered.

Die Heat-Treatment

There are two operations of equal importance in the manufacture of forging dies—construction of the die so that it will register the correct impression and proper heat-treatment. Unless heat-treatment is right, the die is useless and the labor spent on it is wasted. This work is done in a special department adjoining the shop which is equipped with five furnaces. Two have a hearth dimension of 5x10 ft., while the other three are smaller. These furnaces are automatically controlled by pyrometers.

To maintain the cooling oil and water for quenching operations at a constant temperature, a special cooling system has been provided in the heat-treating department. A pump room is located below ground level at one end of the heat-treating building, while nearby is a reservoir with a capacity of 15,000 gal. of oil.

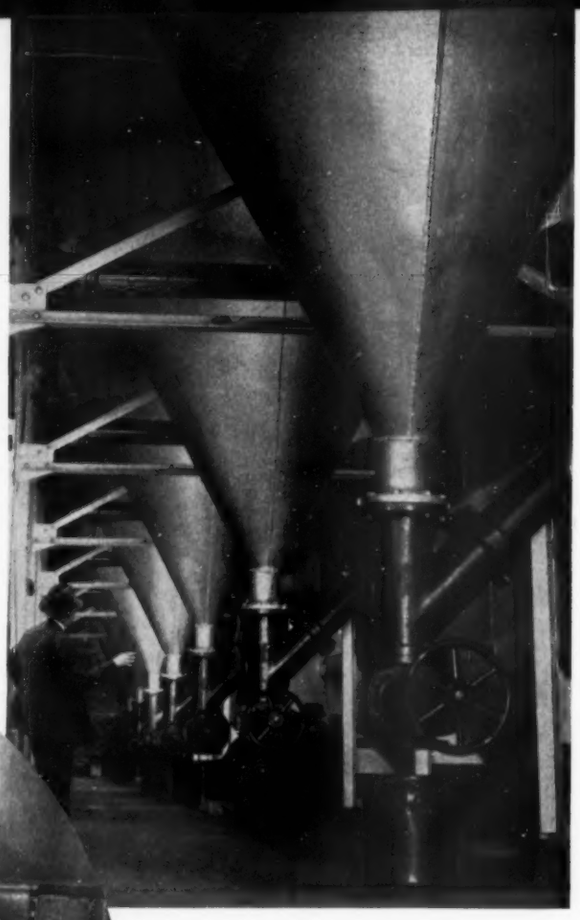
Quenching Oil Is Cooled

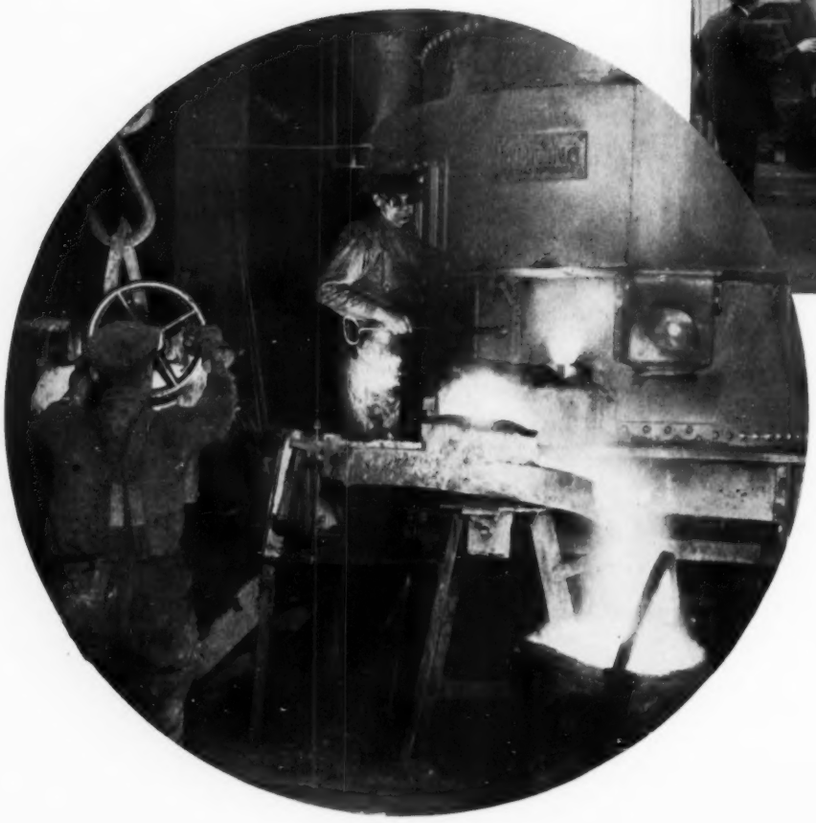
From this reservoir the oil is pumped through pipes laid in trenches to the several tanks at the furnaces. In these tanks the liquid is heated by the work as it comes out of the furnaces. From these tanks the oil returns to a series of coolers located in the same room as the pumps, where the heat is extracted by means of a current of water flowing through the coolers. In this manner the temperature of the oil is lowered, but at the same time the temperature of the water is raised. To cool the water, which is used continuously, the water is pumped to a tower where it falls over grids to a basin, the temperature being reduced while falling.

Forgings are cleaned by the pickling process. The pickling building is designed with special attention to ventilation and illumination. Large capacity fans have been installed at both ends of the building for ventilation. Maximum lighting is secured because the walls are almost entirely of glass. Machines are of the four-arm Mesta type, each arm supporting a basket holding 8,400 lb. of metal. The flow of steam is automatically controlled. The pickling solution is checked hourly and thereby kept at the desired strength. Directly outside the building is an acid storage tank into which the acid is unloaded from tank cars.

● Die blocks are shanked on a Gray planer designed especially for heavy service

A Foundry Built for Men and Metal





● Towering overhead is one row of the ducts that purify air for the Chrysler foundry

● Molten iron pours into a 1,500-lb. ladle under the eye of an inspector

USUALLY, working conditions are nowhere more difficult than in a foundry, with its smoke, dust and heat. Yet modern science is transforming the traditional foundry into a more pleasant place to work.

People who have not visited the Chrysler foundry for some time are amazed at the transformation they see, because the management has installed at considerable cost a ventilating system which removes dust and smoke at the source and supplies large volumes of cooler outdoor air directly to the point where the men work.

The ventilating system consists of a number of booths, inclosures, hoods and openings placed at spots where dust and smoke are produced and connected with sheet metal ducts to two groups of both wet and dry dust collectors. The discharge water, carrying the solids removed from the dust-laden air by means of the wet collectors, is used to pick up the dust accumulated in the hoppers under the dry collectors.

Dirt carried by the water is pumped to two Link-Belt dewatering rotoscoops. These machines remove the coarser sand, putting it on a short belt conveyor which carries it to a loading-out bin located astride railroad cars. The overflow water from the rotoscoops, containing various fine floating materials, is then pumped to a cone-shaped tank, 14 ft. in diameter, where this material further settles. At intervals of one or two hours a hand-operated valve in the bottom of the tank is opened, and the collected sediment is discharged by gravity into the loading-out bin over the railroad cars. From the top of this tank a certain amount of scum, together with a little water, is allowed to overflow to a sewer, and the balance of the water, which has been clarified, returns to the dust collectors by gravity. A small amount of fresh water is continuously added as "make-up" to replace the water lost in

the dewatered solids and "bled" from the final operation of the dewatering process.

The new ventilating system consists in part of 56 fans operated by a total of 1,158 hp. of electric power. It is notable that this installation was made for the benefit of employees so that they would have healthy working conditions.

Aside from the ventilating system, there are many features in the foundry which have increased productive efficiency, decreased costs and enhanced the quality of the work. There are two molding floors, one for cylinder blocks and other heavy castings, and the other for smaller castings. Cylinder blocks are cast two in a mold; the success of this process is attributed to raising the iron to an unusually high temperature and pouring it rapidly.

Previously there were five separate conveyors on the molding floor devoted to lighter castings, each with individual pouring and shake-out stations. On one side of the floor flywheels and clutch housings were poured, and on the other side transmission cases, brake drums, vibration dampers and various small castings. Under the new set-up, there are two centralized pouring and shake-out stations, one at each side. The distance from molding machines to the molding conveyors has been shortened.

Better control of sand has been accomplished by installation of a new sand system, consisting of two Simpson mills, two Jeffrey pug mills and three sand storage tanks. Such elements as moisture, bond, strength and permeability can be regulated closely and better castings thereby be made.

Iron is melted in two cupolas. From these a Shepard hoist takes 1,500-lb. ladles to the pouring stations, the ladles traveling around the sides of the molding floor to protect workmen from the danger of spillage of hot metal. The first iron tapped out of cupolas is not usable in molds and therefore is poured into a ladle and thence into an electric furnace to be preheated prior to being returned to the cupola. This eliminates the necessity for "pigging" the metal and cuts costs. In case a breakdown should occur or delays be encountered on the molding floor, the electric furnace is used to preheat the iron which was in transit to the molds.

Close watch is maintained over the quality of the metal. A "quality man" is stationed in front of the cupola to test every ladle of metal before it goes to the pouring stations. If the iron doesn't measure up to the proper standard, it is taken to the electric furnace to be reconditioned. A "quality man" also is located at the two pouring stations to take temperature readings. The pouring temperature range is 2,680 to 2,720 F. Flow meters have been installed to control the exact amount of air going into the cupolas.

Core making has been put on a scientific basis by means of special core-blowing equipment and ingenious fixtures. In the core-making process tolerances have been reduced to limits heretofore seldom identified with gray iron foundry practice.

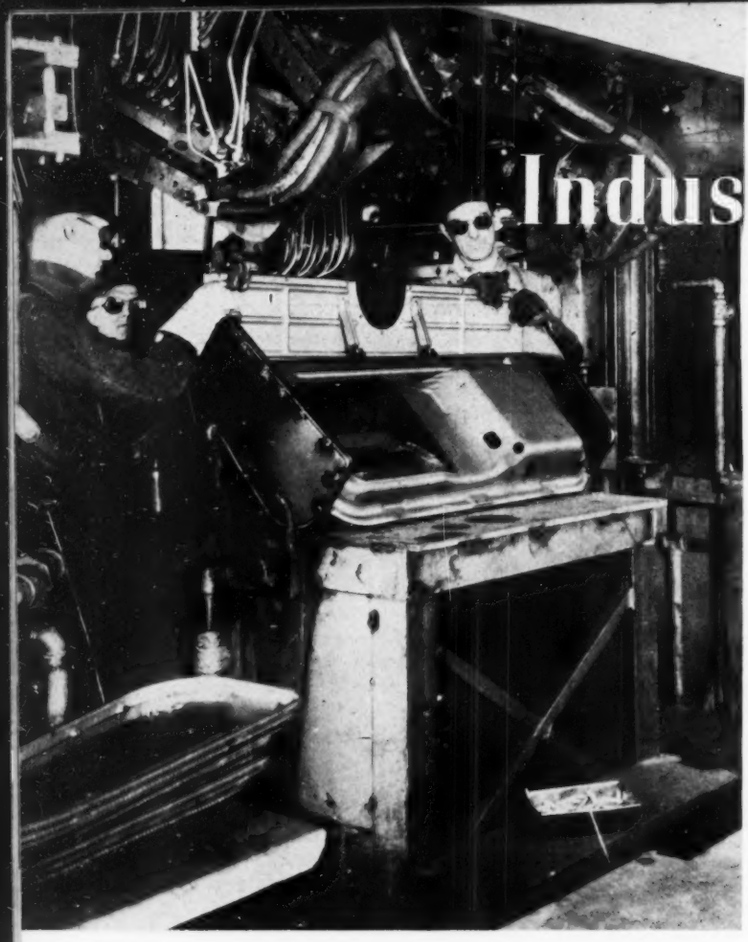
The coring operation is a departure from long-accepted practice. Cores first are set into a steel-faced aluminum gage or fixture, made with the same accuracy as jigs used for machining cylinder blocks. After they are clamped in place, the gage is picked up with a chain hoist, and two complete sets of cores are set in a single mold in one operation. The clamps then are released, and the gage removed ready for the formation of the next set of cores. There are fifteen individual cores for each cylinder block casting.

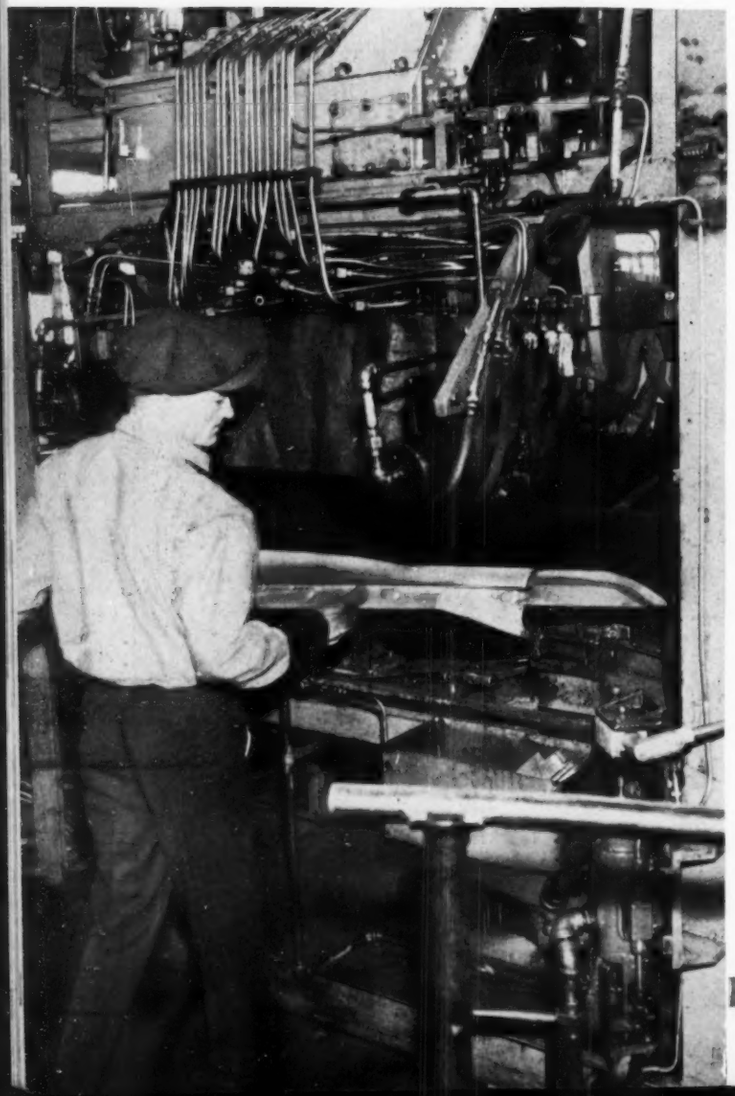
Cores are blown on core-blowing machines, the operation of which is controlled by an automatic valve. The operator starts the automatic cycle of core blowing by a single turn of the valve. Automatic timing of the blowing operation insures uniformity of the cores. At the air intake to the operating valve is a removable air screen preventing foreign particles from entering the valve and causing injury to valve seats. A safety valve prevents the blowing operation if the machine is started without the core box being in the proper position.

At the top of the machine is a large sand bin which can be removed and cleaned. Below it is a sand chamber designed to facilitate the flow of sand. Air pressure used in blowing cores is 120 lb. per sq.in. The machines occupy a minimum of floor space, their operation having reduced the amount of material scrapped.

When metal is poured into the mold, a hood overhead carries away any fumes and dust

Industry's Torch Song





THE FUSING of metal to metal by electricity or by the acetylene torch has added strength and beauty to the car while lowering its cost. Modern streamlining and other innovations of design would be impossible without its use.

The Chrysler Corporation has been in the front rank in its study of welding and in improving its method of application. In its many plants are to be found every conceivable kind of weld from the single spot to that made by the huge flash-welding machine which melts together the edges of two large body panels in one quick flash. In fact, it is practically impossible to name a welding process which is not used somewhere or other in the Chrysler manufacturing departments. Obviously only a few of these processes can be described here.

One of the most interesting developments in this field is the application of what is called hydromatic welding—a process that joins two or more sheets of metal by a series of spot welds. These welds are made progressively, that is two or four are completed simultaneously before the machine starts on the next set. Where welds on a given job run to a considerable number, it may easily be seen that excessively large electrical equipment and power lines would be required to supply the set-up if all were made at one time. The use of the progressive method keeps power lines, contactors, transformers and other accessories within economical size without appreciable loss of time during the operation.

The secret of success in this process is close control, and this is obtained by the use of hydraulics. In general the method followed is first to clamp the work securely in a jig with all parts in their correct positions; the lower part of the jig upon which the sheet-metal rests is a block of copper which forms one of the electrodes. The upper electrodes, arranged in pencil-like points, are held in a frame which is lowered by a pneumatic ram until each point is about ⅛ in. above the surface of the metal. These points are mounted on small pistons operating in small hydraulic cylinders; from each a copper pipe leads to an oil valve located in the control box. The valves are operated by a series of push rods which in turn are actuated by a wedge-shaped cam moved across them by means of a revolving leadscrew. But, in addition to opening these

• Six seat members are assembled and spot welded in this machine with the upper electrodes "hydromatically" controlled

• Each of the brass tubes seen above carries oil pressure to two welding points to time the progressive welding of the sedan side sill

Means Harmony in Design

Hydromatic welding is only one of many developments that aid in fashioning fused metal for the modern car

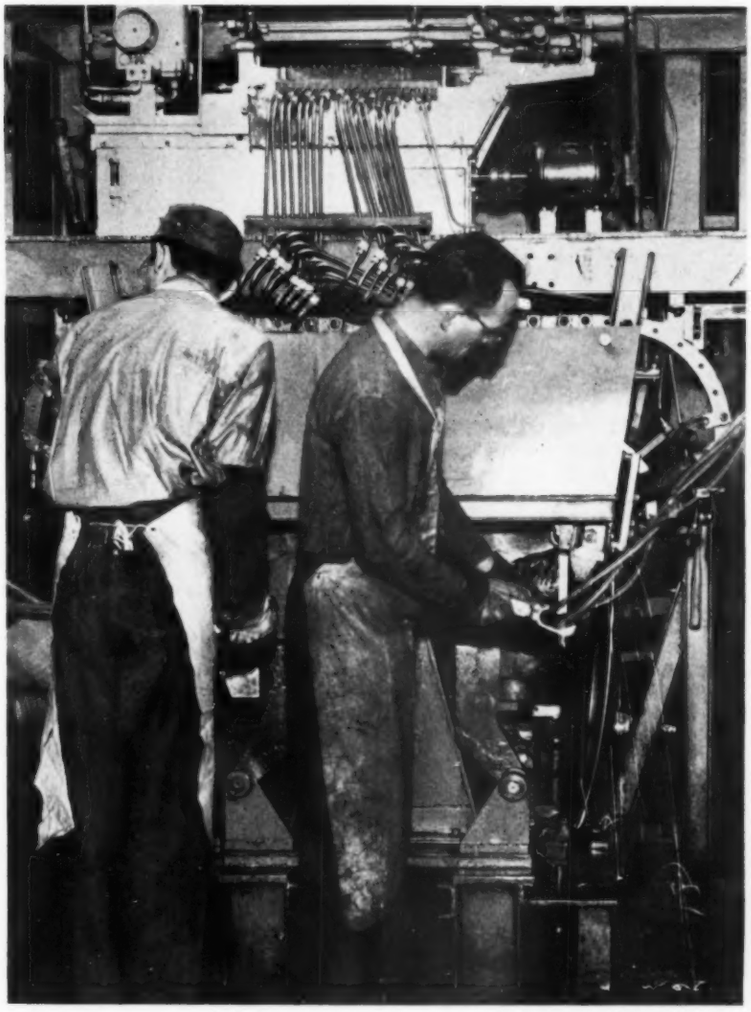
valves, the push rods are arranged to trip the electric contactors an instant after the corresponding oil valves are opened.

As the cam starts its travel, it hits the first push rod and allows oil under pressure to enter the first pipe line which forces the corresponding electrode against the metal to be welded. Almost instantly this is followed by the welding current, released by the action of the contactor. The cam is so shaped that it holds the point against the metal a brief space of time after the weld has been completed to give the metal a chance to cool below its fusing heat before the pressure is removed. In like manner each weld is made in turn. By putting a Y into the oil pressure line, one push rod may be made to operate two electrodes. Some of the machines employ two cams, which with Y's in the oil lines, complete four welds at once.

As the cam passes the last push rod, it strikes another contact which operates the valve controlling the upper frame of the machine so that when all welds are completed the contacts are lifted automatically to permit removal of the work.

An example of hydromatic welding is the seat assembly. In this operation six members are joined together: the back, the bottom, two side panels, the toeboard and the tacking strip, which is used to attach the upholstery. This strip is arc welded in place by hand while the machine puts 96 progressive welds in the rest of the members. On the first machines used for this work spot welds were completed in 12 sec. with one seat per min. coming off the machine. The latest machine, which does four welds at a time, reduces the welding time to 6 sec.

In these machines, following the general practice used in the hydromatic process, operation of the hand valve, which closes the frame automatically,



Auxiliary operations are done with Martin guns while the work is in the machine; above may be seen the cam which controls the hydromatic operations

starts the oil pump which builds up the hydraulic pressure and also an air motor for driving the cam screw. Regulation of the air motor controls the rate at which the welds are made. Electrical equipment includes two 75-kva. transformers and two 300-amp. contactors. Foot valves on three sides of the set-up actuate the pneumatic clamps for holding the panels in place. Because of the concave shape inside the seat sides, it is necessary to have the lower electrode made in two halves, one of which slides away from the other during the clamping process.

Another excellent hydromatic welding set-up is for the sill finish panel. To the main stamping, the toe riser and the step strainer bracket are welded in one operation. All of these parts are held down by fingers carried in the movable frame, while 64 spot welds are made four at a time. In this, and other hydromatic machines, when the fixture is raised a safety catch keeps it in place; the catch is not released until the operating handle is turned to start the next cycle.

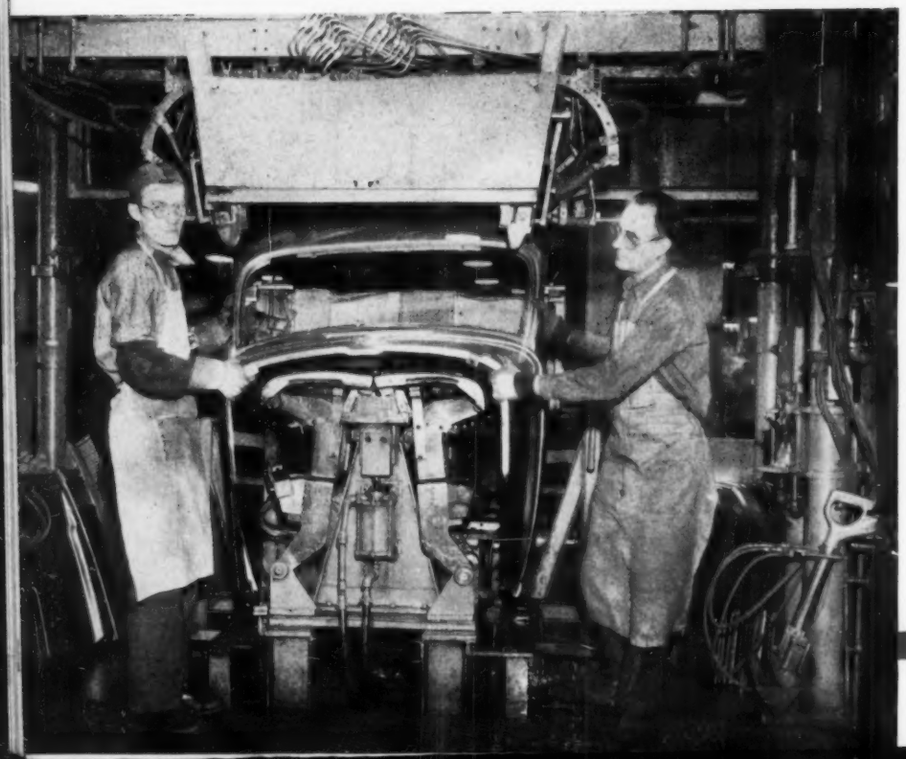
Hydromatic welding is again used on the cowl assembly to join the windshield panels, the cowl cover panel and the two side panels. On this job the progressive spot welds are supplemented by two operators who use Martin guns to join the side panels to the cover panel. The lower electrode slides apart during clamping, actuated by a pneumatic toggle mechanism. The 32 spot welds are formed two at a time with the use of four 35-kva. transformers.

One of the largest applications of progressive welding now in use is the fabrication of the major underbody assembly, which joins the seat pan, the floor pan assembly, two side sills and the rear end skirt. These parts are held in place by four 6-in. air cylinders while 118 spot welds are formed. Electrical equipment includes a 300-amp. contactor and two 75-kva. transformers.

Another method of spot welding that has proved effective is the multi-spot or "grease" system. As its name indicates, this process uses simultaneous fusion of all spots; it is confined, therefore, to jobs where the number of welds is limited so as not to get into unwieldy sizes of electrical equipment.

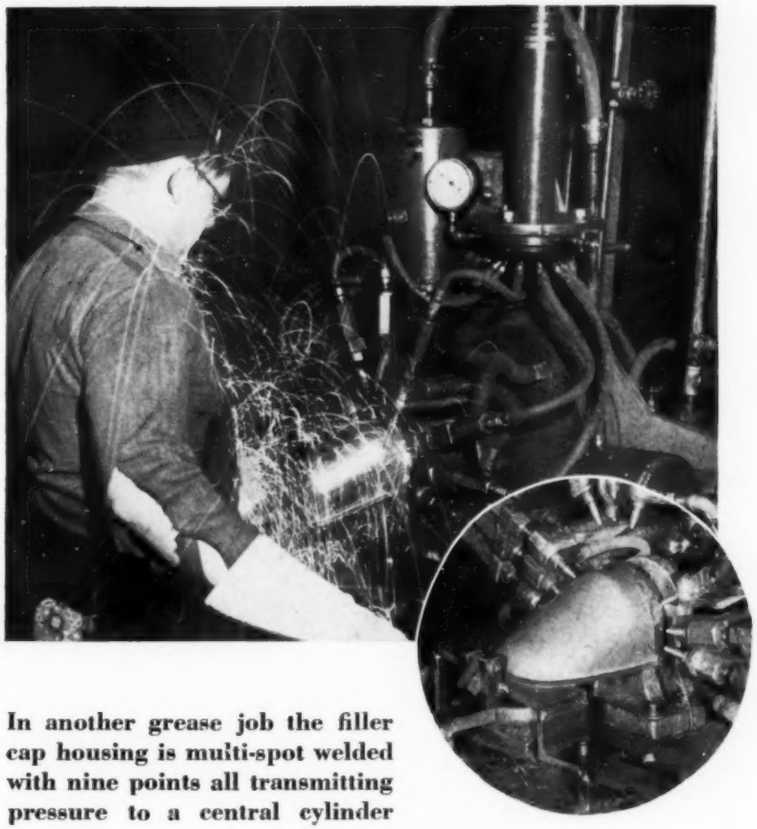
The problem which this method is designed to overcome is to bring all the electrodes against the work at a uniform pressure before the welding circuit is closed. This is done by having each spot-welding point connected to a plunger and tube as in the hydromatic system, but instead of having fluid pressure actuate the electrode, in this case, the electrode is used to build up fluid pressure.

In general the procedure is to mount several of the spot-welding electrodes in a head which is brought into contact with the work by means of an air cylinder. As the welding points touch the work they force back their individual pistons and build up pressure in the grease that fills the tubes connecting them to a common reservoir. A number of separate heads at different parts



● Completion of the major underframe assembly affords an excellent view of the arrangement of the 118 spot welding points

● Out comes the welded cowl assembly; note the pneumatic toggle mechanism which forces the lower electrode against the concave cowl panels



In another grease job the filler cap housing is multi-spot welded with nine points all transmitting pressure to a central cylinder

Of the many excellent examples of multi-spot welding at the Dodge plant, two will be mentioned to illustrate the practical application of this process. One of these is the front fender when the key plate, support and reinforcement are assembled with it. This set-up uses a 25-kva. and two 15-kva. transformers. Of special interest is the means by which three heads, spaced widely apart, carrying one, two and six electrodes, respectively, are all pneumatically operated to build up pressure at a central point to operate the contactor switch.

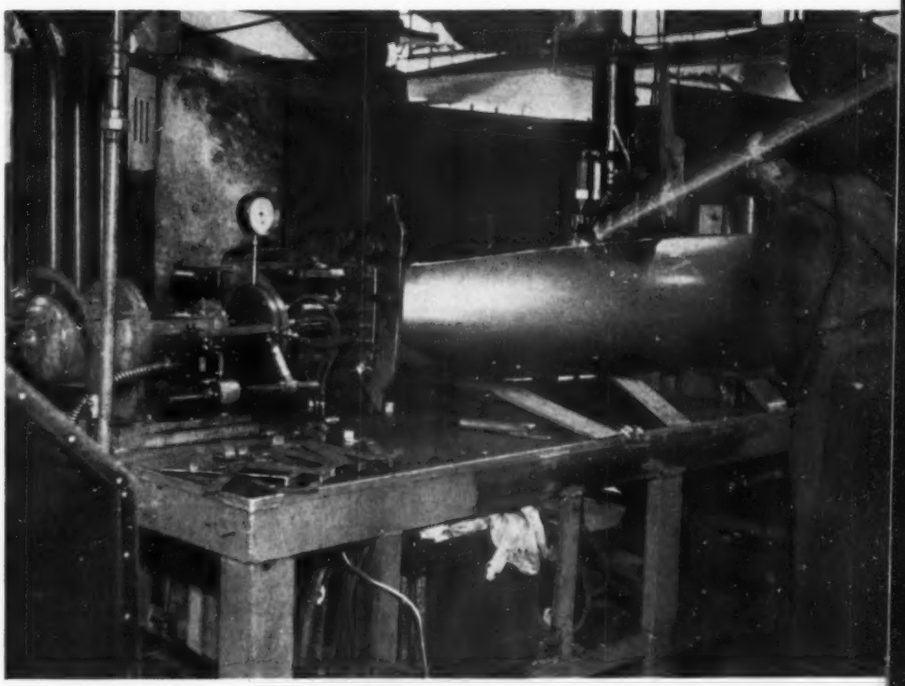
Nine points are welded simultaneously in the filler cap housing in another set-up where the electrodes are located radially around the work. Three air-operated pistons carry three points each. Fingers behind the spot welding electrodes hold the work in place. When the control valve is opened the three heads are forced inward until sufficient grease pressure is built up in the central cylinder above. The grease pressure is opposed by air pressure to secure the equalizing effect desired. When the limiting pressure is reached the contact is operated and the welds are completed. A timer controls the interval of the welding current.

of the work may be operated by independent air cylinders, but the tubes carrying the grease all lead to the same point. The grease acts as an equalizing medium to insure uniform pressure at all the welding points.

When the grease in the central reservoir builds up to a pressure of 500 lb. per sq.in. it operates a pressure switch which controls the contactor that closes and times the welding circuit. When the welding period is completed the contactor releases automatically and sends current through a solenoid that actuates an air valve which withdraws the heads from the work. Consequently all the operator has to do is to put the work in place and move the operating handle either by hand or foot so the welding heads are started toward the work. All the rest of the cycle is automatic.

This welding method has the disadvantage of using the maximum current at one time, but it has the advantage of being simple in mechanical construction and of forming all welds simultaneously. It is useful on smaller pieces or where the number of welds is limited to twelve or fifteen.

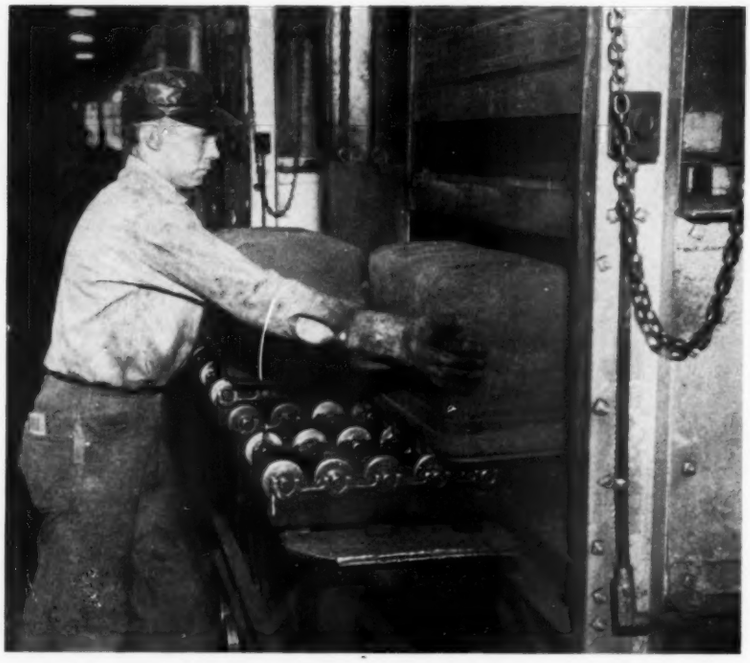
The front fender job shows how three welding heads with nine welding points are made to operate simultaneously by means of the "grease" method



Tough Steels Made Tougher

in the Heat-Treating Department

The loaded box is transferred from a special dolly into the pusher type carburizing furnace



NOWHERE is the control which characterizes all the Chrysler production operations more evident than in the heat-treating departments. This control goes back to the steel mill; every bar and forging must conform to rigid company specifications. Many of these have a basis in SAE standards, but in general, closer limits in composition are required. Chemical analysis of each shipment received, together with strict inspection for flaws, insures adherence to these limits. The heat-treating department at Dodge is the largest in any of the Chrysler plants, because units, such as the transmission, for other Chrysler lines are made here.

One set-up, which forms a good example of the methods followed, is that for processing the axle shaft for all Chrysler cars. Furnaces for this work are located next to the machining department to maintain a continuous work flow. Except for grinding the taper at one end and cutting the keyway, the shafts are completely machined before treatment. Steel is purchased in a normalized state. All grease and dirt is removed in a degreaser before the shafts are carried by conveyor to the charging end of the furnaces.

Filled with carburizing compound from an overhead hopper, the nickel-chrome alloy box is slid along the loading table into the turnover fixture

Two identical sets of furnace equipment are used; both are automatic as to operation and control. The work is carried through two Holcroft heating furnaces by a walking-beam arrangement. As one set of beams is reciprocated, saw-tooth notches hold the

Heated in Hagan rotary electric furnaces, transmission gears are first dipped in hot cyanide and then quenched in oil

shafts, carry them forward a few inches and drop them between similar teeth in the stationary beams. This cycle is repeated, carrying the work ahead a few notches at a time. A Reeves transmission, used in conjunction with a Cleveland speed reducer, regulates the timing of the work through the furnace.

The shafts are made of one of the Amola steels, a molybdenum alloy containing about 0.65 per cent carbon. The furnaces are gas-fired and muffled so the products of combustion do not come into contact with the work; instead the shafts travel through an atmosphere which is reducing and slightly carburizing. The protection thus afforded prevents both oxidation and decarburization, producing finished pieces free from soft spots and scale.

The furnace atmosphere is prepared in a Holcroft generator which cracks and partially burns city gas to give a mixture of hydrocarbons, CO and CO_2. Moisture is removed by chilling to 30 F. Under the control of three Brown recording potentiometers, one for each side of the heating chamber and one in the muffle, a temperature of 1,425 F is maintained. Work leaving the furnaces is automatically lowered by means of revolving screws into an oil quenching bath, circulated to maintain a temperature of about 100 F as measused by a Bristol recorder.

Check on Hardness

The shafts are elevated on an apron and carried by chain conveyor through the gas-fired drawing furnaces maintained at 850 F by Leeds & Northrup equipment. At the exit end of the furnaces, the shafts are rolled out upon a wooden rack from which they are taken to the straightening press. Every hour a number of shafts are tested for hardness on a direct-reading Gogan machine and are required to show a Brinell of 418 to 444. About three hours are required from the time of charging into the heating furnace to the time of exit from the drawing furnace.

Axle shafts are representative of a large number of Chrysler parts that are made from oil-hardening steels. For other parts, such as the ring gear and pinions, carburizing steels are found advantageous. These fall into two main groups: the nickel-molybdenum steels which are quenched direct from the carburizing pot, and the chrome-nickel-vanadium steels, which are carburized, cooled in the pot, reheated and hardened.

Carburizing furnaces consist of two 500-kw. 20-ft. Hagan rotary electric furnaces and six straight pusher-type furnaces that have recently been rebuilt to permit direct quenching. The electric furnaces are uniform in action and flexible in operation since they may be speeded up or slowed down to permit almost any heating time cycle. They are used primarily for carburized work that is to be box cooled and reheated before quenching.

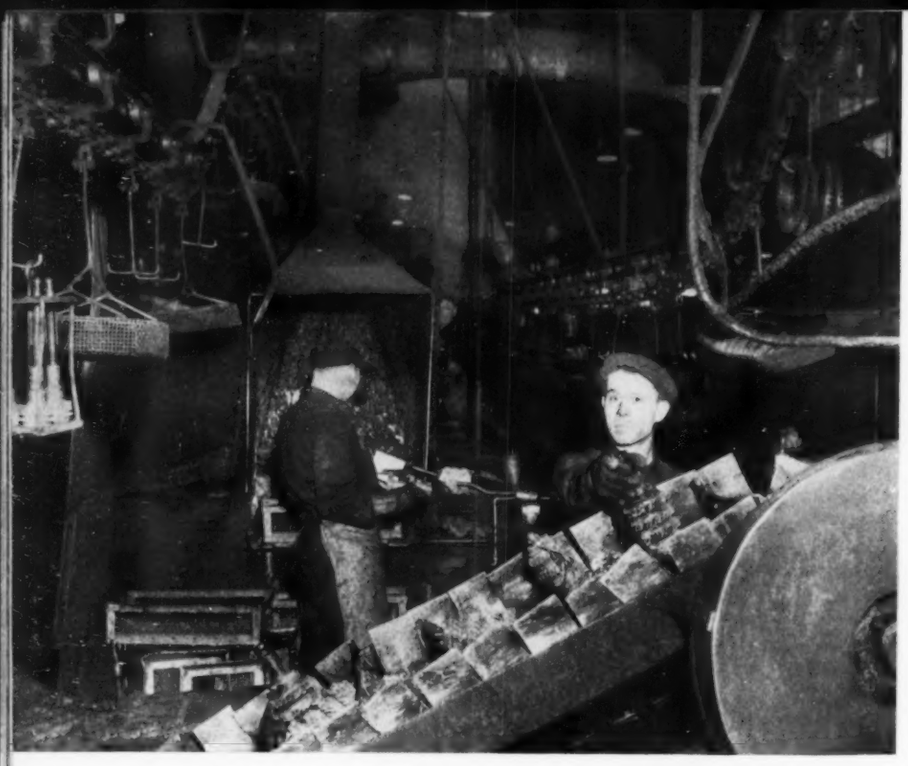
Each of the through-type furnaces is heated by 42 gas burners; the work is pushed through by a ram at intervals up to half an hour, and takes nine to fifteen hours to travel through the furnace. At the exit end of these heating units are four quenching tanks into which the work is quickly transferred after removal from the carburizing pots. The oil in these tanks is cooled to a uniform temperature by a circulating system located in the basement beneath. Strainers in the overflow remove any carburizing compound that may adhere to the work.

Castings Are Annealed

These carburizing furnaces are housed in a building next to the axle hardening furnaces. In this building also are four Rockwell chain conveyor furnaces used for annealing castings, a process conducted to make certain that all cooling strains are removed so distortion will not occur during the machinery operations. Annealing also insures that parts connected with the motor will take their natural shape in the furnace rather than when they are heated in operation of the car.

Two Tum-Blast machines made by the America Foundry Equipment Company are used to clean the castings. In these machines No. 20 steel shot is thrown by centrifugal force against the work while it is tumbled on a steel conveyor belt. Castings are

Continuous furnaces and well planned material handling play a large part in bringing out the best qualities in Chrysler Corporation car parts



● By means of a completely conveyorized set-up hardened gears are carried through the washing machine and tempering bath

● After the backs of the ring gears have been cleaned in a Tum-Blast machine they are turned over to clean the teeth

loaded into these machines by means of an electric magnet.

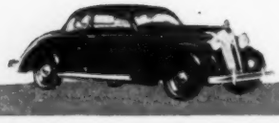
For cleaning manifolds and other castings that have sand and scale in internal cavities, a pickling room is provided. Here the castings are immersed in a ten per cent sulphuric acid solution which removes the foreign matter.

Fixture for Pinions

Three Gleason presses in this department are used in connection with the quenching of ring gears to prevent distortion. These gears are not drawn after quenching. Pinions are placed in a fixture which consists of small rectangular compartments, open at both ends like the partitions in an egg crate. The heat of the pinion placed in each compartment causes a vertical flow in the current of oil. This convection action brings fresh oil against the pinion face, giving each piece a uniform hardness. For other carburized parts an air tempering furnace is provided.

At right angles to the first through-type carburizing furnace is a series of eight roller tables, three of which are used for loading the carburizing boxes while the others are used for cooling. Carburizing compound is stored in overhead bins into which it is drawn by a suction system. Here old and new compound is mixed, usually in a two-to-one ratio, and the dust is removed. Mixed compound is dropped into a storage bin from which it is fed by gravity into the boxes as they are packed. At the end of these tables and

At the discharge end of ring gears are quenched



entirely encircling the furnaces is a narrow-gage track. Loaded boxes are placed on small cars and carried to the charging end of the furnaces. These same cars are used for returning the boxes when they have been emptied.

Special Bolt Furnaces

Practically all the 1,800,000 bolts that this plant makes daily must be heat-treated; this work is done in two bolt furnaces. One of these, a Holcroft, has the bolts fed into a hopper at one end where they are carried through the heating chamber on an alloy plate belt and are automatically quenched at the other end. The quenching bath on this furnace is mounted on a car truck. It consists of two compartments, one of which is filled with oil and the other with water, so by merely shifting the tank either cooling medium is available. When carbon-steel bolts are in process the water quench is used and when alloy-steel bolts are being heat-treated the oil quench is used. By means of conveyors, the bolts are lifted from the tank and carried back through the drawing furnace. At the discharge end they are dumped into a soluble oil bath to color them, and an apron conveyor transfers them to a tote box. The other bolt furnace is somewhat similar in construction except that only a water quench is provided. Both furnaces are gas fired.

In the Dodge heat-treating department there are 40 oil-fired cyanide pots with automatic temperature control and signal lights to show whether they are above, below or at the proper heat-treating temperature. When work is put into the pot the temperature naturally falls, but the operator, by watching the light, can tell when it is ready to quench. About a dozen quenching tanks are placed to be within easy reach of the pots. For drawing there are two Homo electric air-tempering furnaces, a salt pot and four gas-fired oil tempering baths.

Presses for Quenching

Work which is especially susceptible of distortion is provided with special quenching presses or fixtures of some kind. For instance, the gear shifters which are used in the transmission are quenched in hydraulic presses; a jig is provided for the intake valves.

For small shafts a Holcroft shaft furnace has been installed. Such parts as oil pump and differential shafts are placed in a series of slots in which they are pushed along longitudinally by means of a cam mechanism. For annealing cold-headed and coined parts a Hoskins electric furnace is available. Stainless-steel manifold bolts are heated in a batch-type furnace to 1,750 F from which they are oil quenched to produce a hardness of 45 C Rockwell.

Electric Heat for Gears

A conveyorized set-up is provided for the transmission units with the parts grouped in special holding fixtures. For this work five Hagan electric rotary furnaces are used. The work is kept for 45 min. at 1,485 F after which it is dipped in hot cyanide and quenched in oil. The conveyor carries the parts through a washing machine and then through a salt tempering bath; after this they go through another wash. The rotary furnace used for spline shafts has special holders in the hearth to receive these parts.

Ring gears for the rear axle, which have been box cooled from the carburizing heat, are reheated in two Electric Furnace Company's roller hearth double-decked furnaces. At the discharge ends there are seven Gleason quenching machines for cooling the work without distortion. A special Tum-Blast cleaning set-up has been installed to remove all traces of scale and dirt after quenching. These gears are then tested on special indicating fixtures and are held to 0.002 in. both as to flatness and roundness.

Axle Pinions Carburized

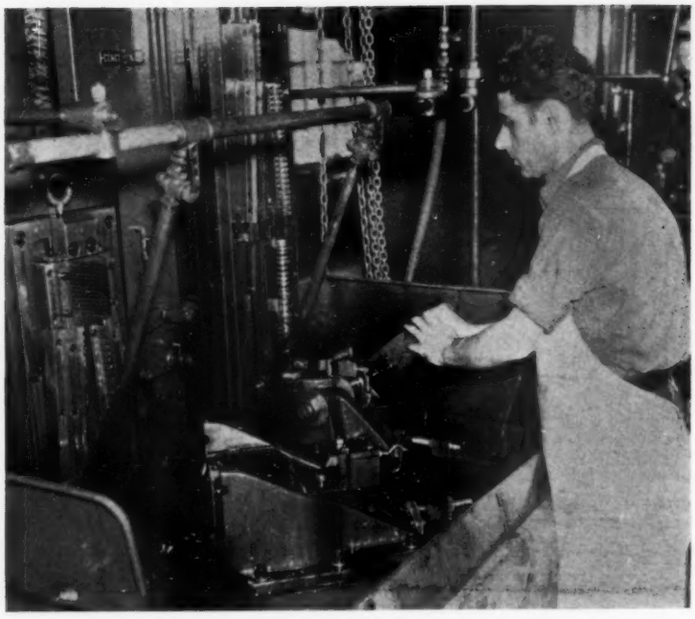
The axle pinions, which have already been carburized, are heated in cyanide at 1,300 F for 15 min. They then go into a lead pot held at 1,440 F for 6 min. and are quenched in oil. The heating units are arranged in threes: that is, one lead pot between two cyanide pots, since the lead pot handles the work twice as fast.

This description deals with only a few of the many thousand parts heat-treated at this and other Chrysler plants every day. These examples will serve to give an idea of the magnitude of the job handled and the care exercised to control every phase of it.

a double decked electric furnace, in a battery of Gleason machines

Feelers and indicators aid in the everlasting effort to insure precision

Six at once, the rods are drilled at the wristpin end in a multiple-spindle machine



Rods and caps are broached together in a duplex broaching machine that finishes faces and bores in one pass

Connecting Rods Machined by Broaching

Processed in pairs before assembly, diamond bored afterwards, rods and caps must run the gauntlet of the electric gage

HOW Chrysler Corporation makes connecting rods typifies its forward looking policy on machinery. Methods employed reflect an open mind toward new developments and a readiness to adapt problems.

The connecting rod proper is made of an alloy steel forging with a cap of the same material. Upon its receipt in the machining department, the rod is placed in a fixture and straightened by hand. The straightening fixture is so constructed that it also serves as a gage to check the position of the rod bosses.

Then follows the first broaching operation. This method of machining characterizes the connecting rod line because it differs radically from the operations previously used to perform this work. Four broaching operations are performed on the connecting rods, and all use Cincinnati Duplex Vertical Hydromatic machines. In each case two fixtures for holding the work are used, one of which is loaded while the other holds the work in contact with the cutter. A single operation pneumatic clamp holds the rod while lugs position it properly.

The first broaching operation machines the sides of the crank end of the rod. The tools last 21 hours between grinds on this work; they turn out 360 pieces per hour.

Next the wrist pin holes are drilled. Again a double fixture is employed, each side of which holds six rods or enough for a single car. The three machines used on this work are each capable of an hourly output of 160 pieces. Roller gravity conveyors carry the work to and from this operation.

Both ends of the wrist pin hole are then chamfered in a single spindle

vertical drill press which has been equipped with foot treadle feed. Rough reaming follows with the work held in an air clamped equalizing fixture and cut by a piloted tool.

Top and Sides Together

The second broaching operation machines the sides and top of the bolt bosses on both the cap and the rod. These two parts have not been assembled, but they are clamped and cut in pairs to balance production. For this work the broaching tools are good for 105 hrs. between grindings.

The third broaching, that for the joint faces and bearing halves on both the cap and rod, follows. An ingenious set-up uses three sets of broaching tools for each piece which rough face, and finish face and bore successively in one pass. Each of the two machines used for this work is capable of an output of 180 sets per hr. The tools are good for 2,880 pieces between sharpenings.

Oil holes are drilled $\frac{1}{8}$ in. counter drilled and chamfered in a four-station Kingsbury automatic machine using hydraulic feed. This machine replaces three separate drilling operations. A plain hydraulic milling machine then cuts grooves in both the rod and cap to keep the bushings in place. A double fixture on this machine reduces lost time in setting up the work. Joint faces on both parts are then ground on a Gardner disk grinder, with a pivoted table to rock the work across the wheel. Fixtures locate the ground surface from the wrist pin hole in the rod.

Six pairs at a time, bolt holes are drilled and reamed in the rods and caps in a four-station machine. Next the bolt holes are chamfered, counterbored and spot faced, using a combination tool.

After the burrs are filed from the joint faces, the rods and caps are assembled. First, the bolts are put loosely in place while the work is carried through a washing machine on a monorail conveyor. The bolts are then tightened and the parts placed in a tote box for transfer to the reaming operation.

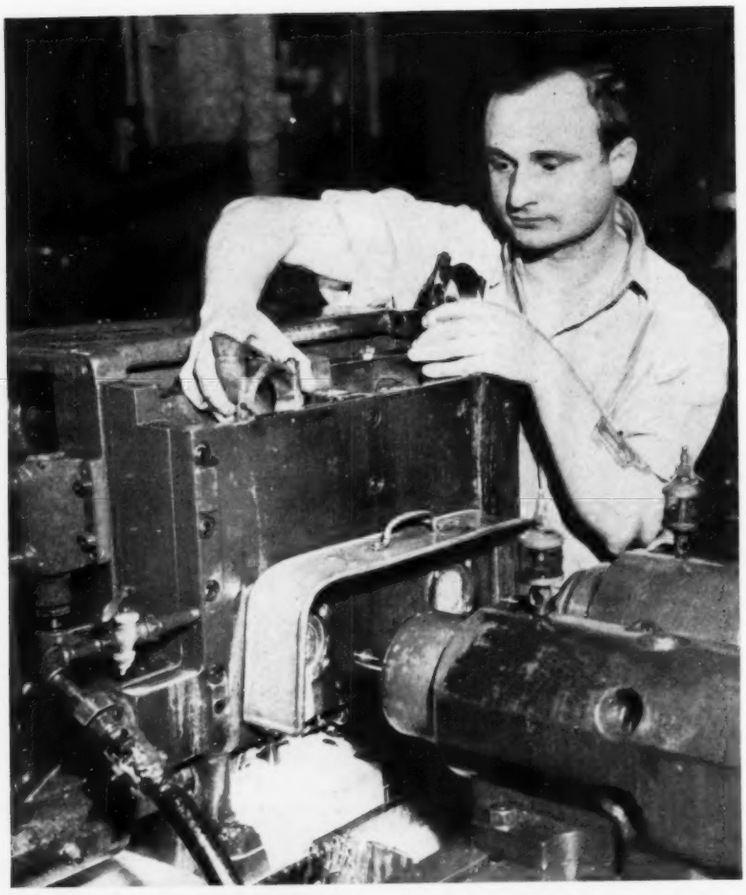
Both Ends Are Reamed

The wrist pin hole is first reamed, located from the crank end and clamped in a pneumatic equalizing fixture on a W. F. and John Barnes drill press. Then the crank end is reamed to grinding size using the wrist pin hole to locate; this cut removes about 0.012 in. of stock. Of a battery of eight reaming machines, three are employed on the wrist pin end and five on the crank end.

A Rockford double-end machine then chamfers both sides of the crank pin bore simultaneously. Bushings are pressed into the pin end using a Toledo punch press; the tool used for this pur-

● Clamped in a pneumatic equalizing jig the crank ends of the rods are reamed

● A Heald grinder finishes one face at a time with the rod held on a locating plug



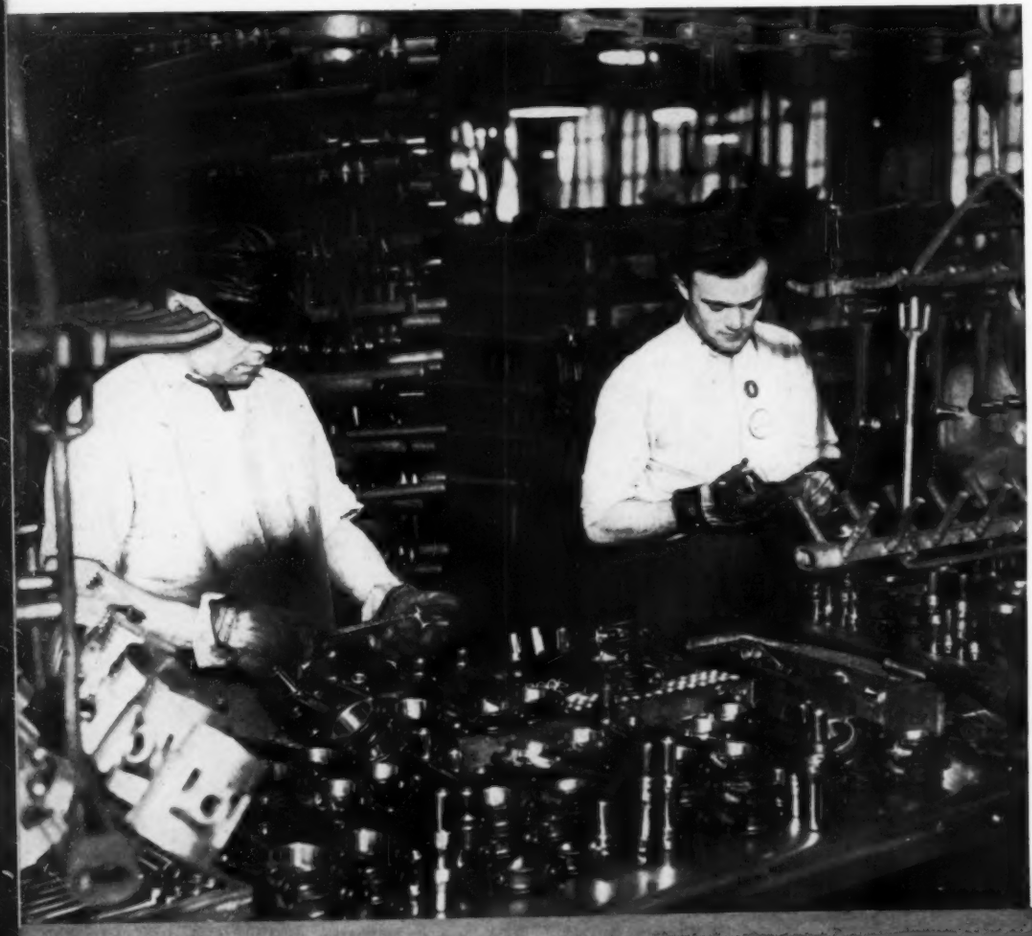
pose also burnishes the bushing bore in the same stroke. A Kent-Owens hand miller saws an oil slot in this bushing, and then both ends are chamfered in a double-end machine.

The fourth and last broaching operation cleans up the rods around the outside of the bolt bosses for clearance and appearance. Since this is a light cut the tool lasts two to three weeks without resharpening.

Rods Ground Internally

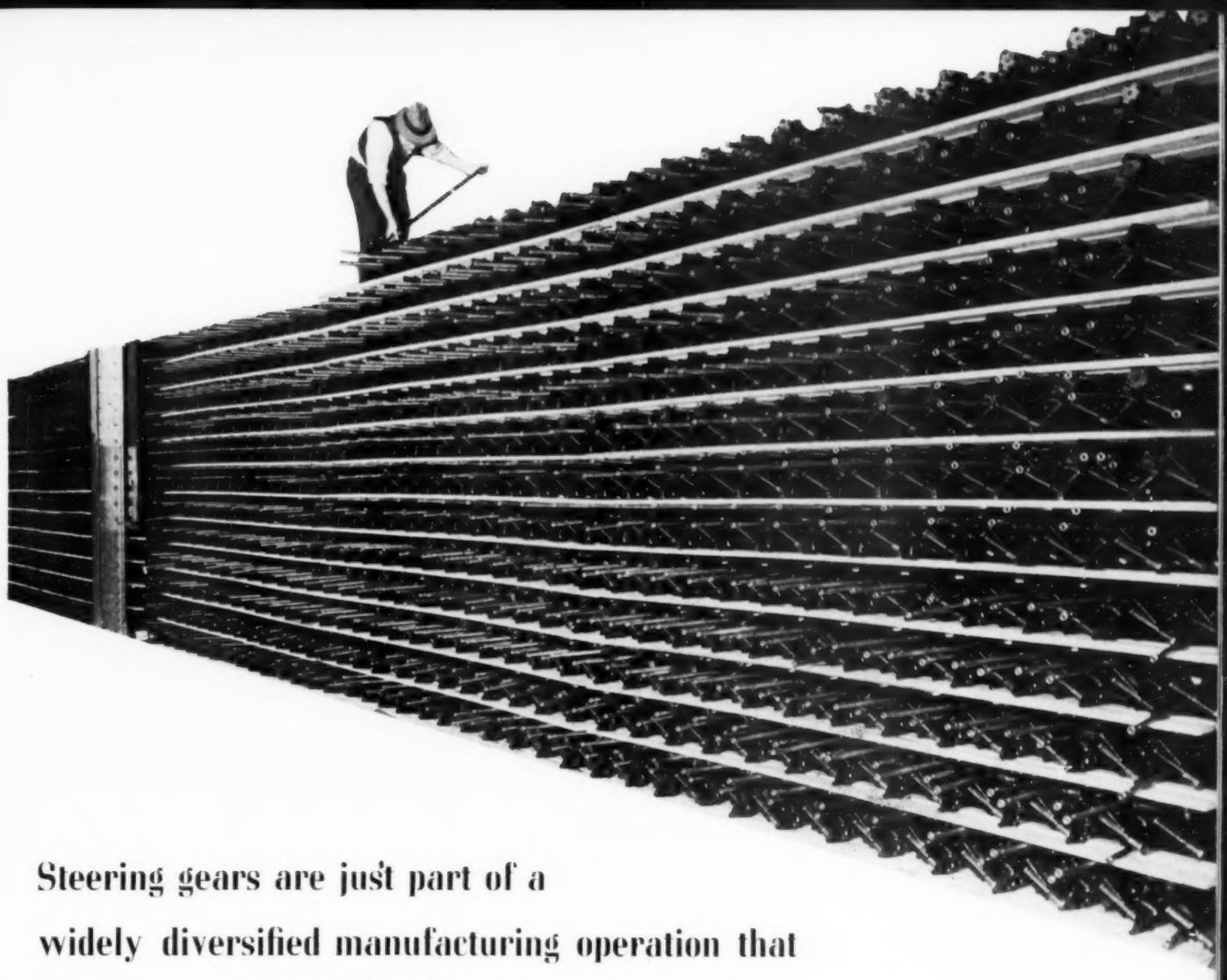
After this operation the connecting rods are taken to another department where the cap bolts are loosened and then retightened to relieve any strains that may have occurred during the machining operations. Then two sides of the crank end are ground on a Heald surface grinder using a rotating fixture at a rate of 100 pieces per hr. The crankpin bore is ground on a Heald Gagematic internal grinder to limits of 0.0005 in. An Ex-Cell-O duplex machine diamond bores the wrist pin bushing keeping the dimension within 0.0002 in. of size.

A Pratt & Whitney electric gage is used for inspection. Wrist pines are fitted by selective assembly which insures that they will rotate smoothly and snugly in the rod.



Final sizing of the wristpin holes is done in a double-spindle diamond boring machine

After selective assembly of rods and wristpins, a check is made for push fit



Steering gears are just part of a widely diversified manufacturing operation that turned out 90,000,000 lb. of work last year

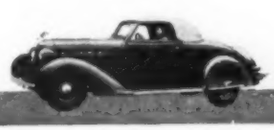
Carrying Parts Through Newcastle

ONE of the larger operations within Chrysler Corporation is the manufacture of parts at its Newcastle, Ind., plant. Covering 600,000 sq.ft. of floor space, this single-story factory makes steering gears for Dodge and Plymouth divisions and tubular axles. How these two products are made is of special interest.

The plant likewise builds a variety of car parts—steering knuckles, steering arms, transmission shaft flanges, rear axle shaft flanges, steering tierod assemblies, overdrive mainshaft and free-wheeling cam assembly, hydraulic brake cylinder pistons, front axle I-beam assemblies (for trucks), independent wheel suspension forged machine parts and miscellaneous heat-treated automatic screw machine parts —to name only a few.

The Newcastle division consists of a forge shop, machine shop, die shop, heat-treating and pickling department and modern power plant. The forge shop makes connecting rods, clutch pedal and brake pedal forgings, and other parts which are shipped to Detroit plants of the corporation to be machined. The magnitude of operations at Newcastle is indicated by the fact that in 1935 the plant shipped 80,000,000 to 90,000,000 lb. of finished parts.

As in other divisions of Chrysler, at Newcastle the plant is conveyorized mostly by means of an overhead monorail system over two miles long from which work is suspended on special fixtures. Electric lift trucks supplement the conveyors. Automatic washing machines are located overhead, being built into the conveyor line so that the



Finished tubular axles come off the line devoted to operations performed after heat-treatment

The forge shop furnishes parts that go into assemblies made at Newcastle and also rough forgings for other Chrysler plants

work flows through them as it moves from one operation to another.

Tubular axles are made of seamless steel tubing 2¼ in. in diameter, the tubing being delivered on a gravity conveyor direct from railroad cars to the first operation. Tube ends are squared on a Bliss press and a slot is milled in each end of the tube, to receive the pivot pin spool, on a Sundstrand two-spindle miller. The spool is assembled, and the ends of the tube are formed around it in a double-end 40-ton horizontal wrapping press exerting a pressure of 20 tons on each end.

End seams of the tubular axle are then electric arc welded, a weld 2¼ in. long being made at each end of the axle. The operator uses a 400-amp. Westinghouse portable arc welding generator for this purpose, production amounting to 40 axles an hour. Immediately following this operation the spools are arc welded to the tube in a special rotating machine equipped with General Electric heads. One end of each spool is circular welded in each of two operations after which the axle is formed to the proper camber and castor angles in a large straight-side forming press. Then the other end of the spool is welded. The second welding operation is postponed until after the axle is formed so that there is no chance of welds breaking. Each operator makes 80 circular welds an hour, an output equivalent to 20 axles.

Axles are put in a press and bent for clearance, and the welds on both ends of the axle are snag ground. Spring seats are electric arc welded to the axle by hand. Up to this point, axles have progressed along a production line on both sides of which are machine tools and welding equipment. They are carried from one operator to the next crosswise on a gravity conveyor. After the welding of spring seats, axles are taken by truck to the heat-treating department where they are hardened in a Holcroft pusher-type gas hardening furnace and quenched in a special Gogan axle quenching machine which does not distort the axle during the quenching operation.

When axles are removed from the furnace, they are placed on the lower die of the quenching machine, the upper die automatically closing on the axle. The complete unit then is submerged in oil for one minute. When removed from the quenching medium, they go through a draw furnace and are tested for hardness. For testing purposes a spot is polished on the axle.

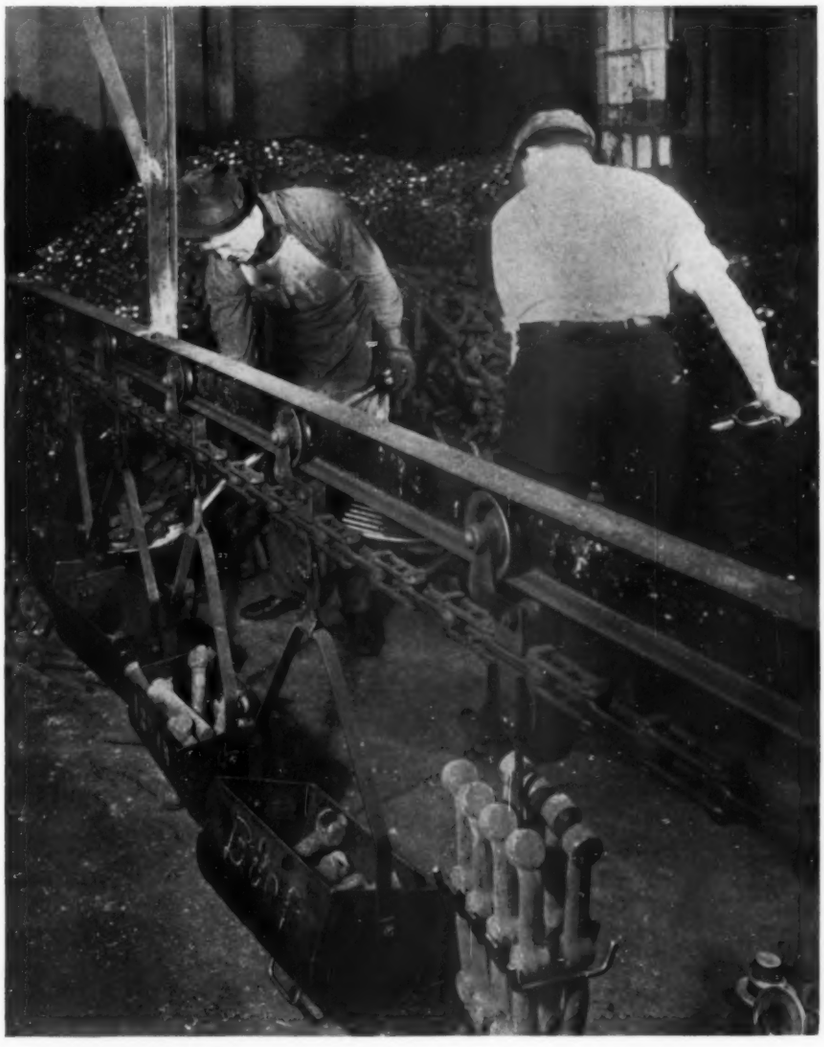
After passing inspection, they are cleaned in a Pangborn Shotblast rotary table machine. The table, 8 ft. in diameter, has a blasting area of 40 sq.ft. and is equipped with two high-pressure oscillating nozzles, a steel abrasive being used. The shot-blast machine automatically refills, the refilling process being synchronized with the rotation of the table. All parts of

the machine exposed to the blast action are protected by manganese hard iron wear plates. Two machines clean 100 axles per hour. To utilize the capacity of the tables to the best advantage and to prevent axles from rolling, miscellaneous small forgings are put between the axles while the latter are being cleaned.

Axles are hauled back in electric trucks from the cleaning machines to a production line paralleling the first line, the trucks carrying 400 axles in each load. Axles are straightened in 50-ton hydraulic axle straightening presses which are rigid enough to resist the pressure of heavy work and are equipped with hydraulic valves permitting rapid approach of the ram to the work and an automatic change to slow travel on reaching the work. The remainder of the travel and the ram pressure are controlled by foot pedal, the ram automatically returning rapidly to resting position when the operator releases the foot pedal.

The king pivot pin hole is drilled on a Barnes rail drill. A series of spot facing operations on the pivot pin bosses follows. Lock pin holes are then drilled, chamfered and tapped, and the pivot pin holes are line reamed.

Axles are straightened again and inspected in a special fixture to check the caster and camber of the pivot pin holes in relation to the spring seats. To insure accurate height and alignment, spring seats are ground on spe-



● **Small forgings are shoveled into conveyor buckets to be carried by monorail to the machine shop**

● **A Pangborn rotary-table shot-blast machine cleans the tubular axles**

cial duplex grinding machines equipped with special pad grinders. Each axle is inspected 100 per cent at the end of the line.

Forged steering gear sector shafts are normalized, hardened and drawn before going to the machining department. They are required to show a Brinell reading of 269 to 308, or three points harder than the average heat-treated forging. An angular slot is broached in the shaft on a 15-ton Oilgear hydraulic broaching machine, the broaching being so accurate that additional sizing operations are unnecessary. A cross hole at right angles to the slot is drilled and reamed on a Natco two-way hydraulic drilling machine.

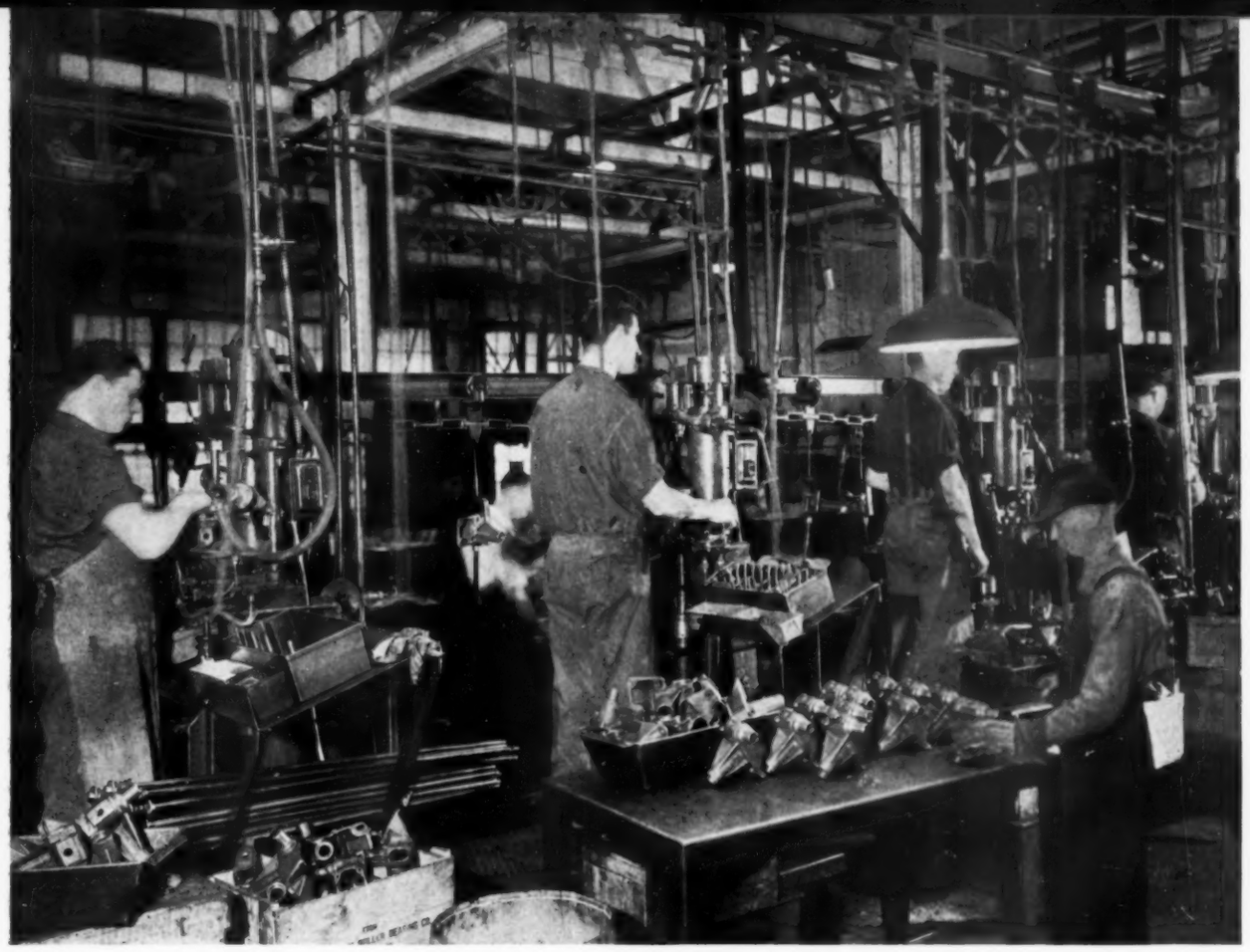
Steering gear sector shafts are delivered to the assembly department on a trolley overhead conveyor and the roller tooth and pin are assembled in the shaft and the ends of the pin upset in a special hydromatic electric upsetting machine. The pin is heated locally to a sufficient temperature to upset each end about $\frac{3}{32}$ in. without changing the hardness of the center portion of the pin, which previously had been carburized. The complete upsetting operation takes three seconds.

Hour-glass worms for the shafts are blanked from steel bars 2 in. in diameter and 12 to 16 ft. long. After the hole is broached, worms are generated on Fellows hour-glass worm generators. They are hardened in rectangular liquid bath gas furnaces located in proper sequence in the production line.

Pivot-pin spools are welded to the ends of tubular axles by means of a rotating fixture and a General Electric head

An American broaching machine cuts the mounting pad on the malleable iron steering gear housing

Ends of the pin of the steering gear sector are upset in a special hydraulic unit



Parts are carried to the steering wheel assembly section on a monorail conveyor typical of two miles of such equipment at Newcastle

After hardening they are inspected 100 per cent on a Gogan diamond hardness testing machine at the rate of thirteen a minute. Worms are assembled on the steering tube, which is hung on a trolley conveyor to be delivered to the assembly department, passing enroute through an overhead washing machine.

Malleable iron steering gear housings are bored, reamed and faced on Goss & De Leeuw chucking machines. Due to the design of the housing, fixtures on these machines are stationary and only the tools revolve. The mounting pad on the housings is broached on an American vertical broaching machine, the broaching tools cutting at a rate of 25 ft. a minute. Depth of the chip is the same from the beginning of the broaching operation, to the end, the result being a better finish and more accurate machining. Three holes are drilled in the mounting flange of the housing on two vertical six-spindle Natco drilling machines equipped with semi-automatic hydraulic feeds and arranged with flat slides for the mounting of fixed-center gear driven drill heads. Both machines are mounted on a high-type base on which rests a stationary fixture arranged to hold two gear housings. After the holes in the frame mounting pad are elongated on a punch press, housings are hung on a conveyor which transports them to the assembly line.

Blanks for the steering gear roller tooth are cut on Cone automatic machines from bar stock and then carburized, hardened and ground to finish size. The hole is ground on an internal grinder. The inner face of the teeth in the roller tooth is ground on a special set-up on a No. 2 Cincinnati centerless grinder, which consists of a centerless grinder bed, standard grinding wheel spindle head and drive, standard gear box and a special work head instead of the standard regulating wheel housing. The head rests on a wide dovetail base, giving adequate support and a smooth, accurate movement to and from the grinding wheel, which is a 20x1x12 in. 60K-31 Aloxite wheel. Hydraulic truing and profiling for the grinding wheel is the same as on a standard machine. The work is put on a special chuck which does not rotate in the loading position. On the forward or infeed movement, the chuck locks the work securely in place and causes it to rotate at the correct speed.

All major parts of the steering gear are delivered to a master overhead conveyor which passes alongside assembly benches, where operators remove and assemble them. After being assembled, steering gears are hung on a second conveyor to go to final inspection and to the spray booth to be sprayed with lacquer. The final assembly operation is on a Logansport special hydraulic assembling machine. Steering gears, after rigid inspection, are sent to storage at the end of the department or are put on skids and taken direct to the loading platform for shipment to Chrysler assembly plants.

The overdrive mainshaft for Chrysler-made cars is forged from nickel-molybdenum electric steel in the forge shop at Newcastle. All surfaces are rough and finish machined and the entire forging copper plated, after which bearing surfaces are machined to remove the copper plating to permit localized carburizing. Succeeding operations include carburizing and hardening, and rough and finish grinding of

Forgings are loaded into a bucket ready to be hoisted into the Wheelabrator Tum-Blast cleaning machine

all surfaces. Extreme care is exercised to keep operations within close tolerances. All bearing diameters and running fits are ground to 0.0005 in. All ground diameters must be concentric with the shaft bearing diameter within 0.001 in. Faces must be square with the axis within 0.001 in.

Forgings and small machine parts at Newcastle are cleaned in American Wheelabrator "Tum-Blast" machines at relatively low cost. Eliminating the use of compressed air, each of the three units consists of an inclosed endless apron conveyor to tumble the work in the blast zone, a Wheelabrator to discharge the abrasive, and an abrasive cycling system to return the abrasive to the Wheelabrator units. Ends of the tumbling chamber are formed by two barrel heads which are 36 in. in diameter and are spread either 42 or 48 in. apart, depending on the capacity required.

This method of cleaning makes use of centrifugal, tangential and air-dynamic forces. Abrasive is fed by gravity from a storage hopper to the center of the Wheelabrator wheel. Rotating at 2,200 r.p.m., the Wheelabrator ejects the abrasive at tremendous speeds and in a stream 4 in. wide. A special rotary feeding device controls blast distribution.

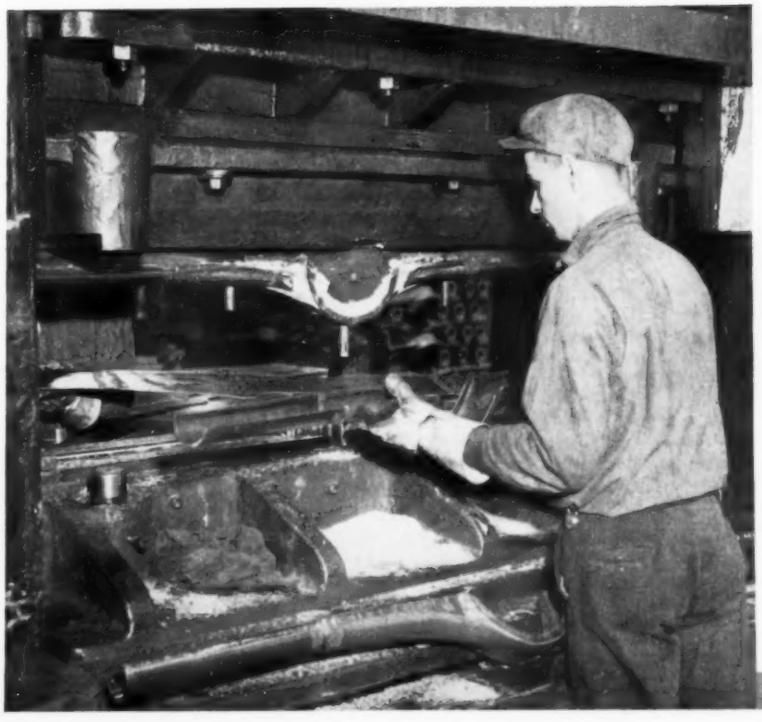
After discharge from the Wheelabrator wheel, the abrasive falls between the staves of the apron conveyor and is carried by a screw conveyor to the rotary screen at the boot section of the elevator. Here it is thoroughly sifted to remove foreign materials, after which it is conveyed by a bucket elevator to the storage hopper above the Wheelabrator. From this hopper it is fed by gravity through valved control to the Wheelabrator wheel. Equipment is operated in conjunction with a tubular filter and exhauster for removing dust and broken-down abrasive. Forgings are loaded into the machine by means of a bucket operated by a one-ton electric hoist. After being cleaned, they are unloaded by reversing the endless apron conveyor. Work is loaded, cleaned and unloaded at the rate of 1,200 to 1,600 lb. in 8 to 20 min., depending on the condition of the material to be cleaned.

Furnace equipment at Newcastle of necessity must be adaptable for a large variety of work; here are a few gas-fired units

● **Butt welding the sheet steel stock before forming gives a desirable variation in blank thickness**

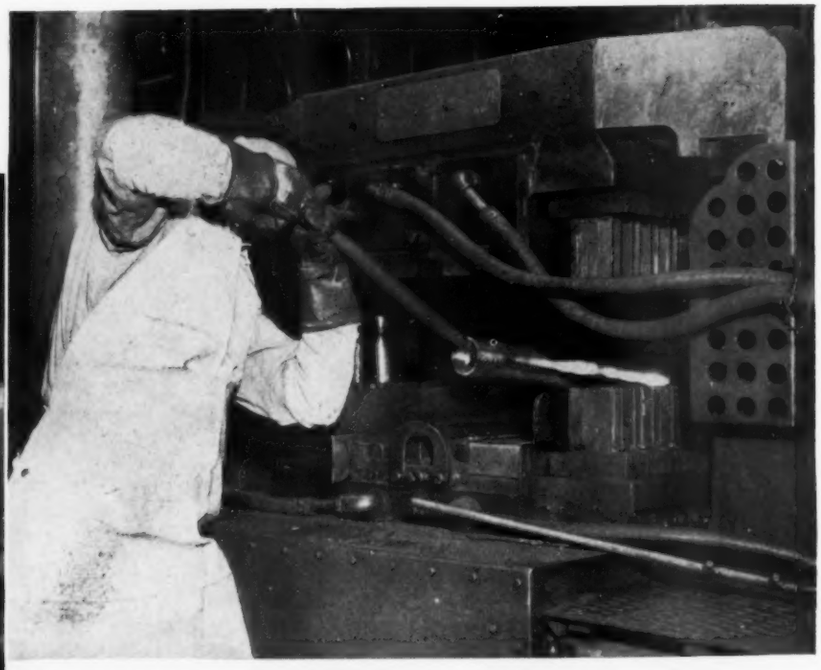
● ***Below*—Half a housing is formed in one stroke of a Bliss press**

Welded Sheet Steel Houses the Axles



PROBABLY no part of the Chrysler Corporation's cars better exemplifies the application of pressed steel than the rear axle housing. Many combinations of castings, forgings and tubular stock have been employed in other designs of this difficult member, but on these cars the banjo housings, the tubular sections extending at each side, the flanged ends and spring supports are all made from flat rolled stock. Fabrication is an ingenious combination of press work and welding which results in manufacturing economy and increased strength. The entire process is housed in the Highland Park plant.

The housings are first made in two halves, each of which consists of three pieces of sheet metal. This construction permits the use of $\frac{7}{16}$-in. stock for the end sections and $\frac{5}{32}$-in. stock for the center section which must be deeply formed; it also results in a saving of material because when the center section, which has something of an hour-glass shape, is blanked from the sheet it can be staggered to cause a minimum amount of waste. This staggering is not done by using a wider sheet but by making the center sections longer at one end than at the other and alternating the longer ends from right to left. One end piece is



● *Above*—**Ten feet of weld are completed in one flash which joins two half housings**

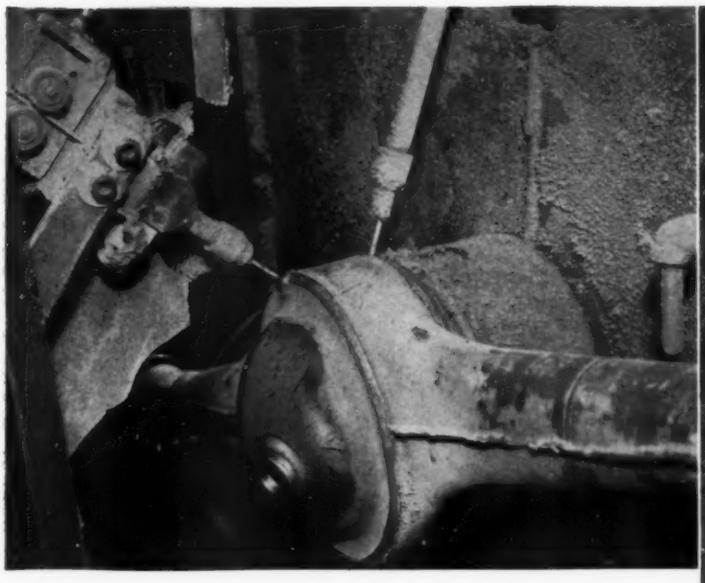
● *Upper right*—**Still aglow from the welding heat, the fused housing is removed from the electrodes**

● *Lower right*—**Steel caps placed on the housing ends prevent convection currents which would otherwise cause scale formation when the work is heated**

made longer than the other to restore the symmetry of the blank. Welding is done in Federal, Metropolitan and Swift butt welders, using locating gages to align the stock. First one end is joined and then the other; a Vulcan shear removes the flash after each operation.

The welded sheets are then formed in one operation to make a half housing. The piece is restruck on the side to set the banjo section and then coined on a 2,500-ton Toledo knuckle press with the open side up to straighten all edges. This makes it ready for welding except for a small piercing and embossing operation which is done in a No. 55 Toledo press. The work is then put on a conveyor and carried through a washing machine.

At this point half of the reinforcing ring is welded to the half housing.



After being tacked on, the cover and reinforcing ring are automatically welded tight in a rotating fixture

● A large vertical broach cuts the flash from inside the housing which is supported at the banjo section

When these rings are formed they have a series of small projections embossed into the flat surface. These points are placed against the center flange of the half housing, when the two parts are assembled in the welding fixture, and form points of fusion. The process is called projection welding.

Two of the half housings are then tacked together by hand using regular hand arc welding equipment. They then go through a large Metropolitan welding machine which securely fuses the halves together from end to end including the reinforcing ring. About 10 ft. of weld is completed in this operation requiring a 2,860-kva. Westinghouse generator to supply the current. The flash is removed from the inside of one end; an American broaching machine is used for this purpose.

The housings are then ready for the upsetting operations which form the flanges at the ends. They are carried through a vertical gas-fired furnace on a special screw conveyor which holds the work at the banjo section. Only the upper end is heated, and it is necessary to place a sheet-metal cap over the hole in this end to prevent the creation of an air current which would oxidize or scale the work. As the parts emerge at the opposite end of the furnace, they are immediately placed in an Ajax or National forging machine where three strokes upset the end flange. Again the flash is removed by the use of a vertical broach. The other end of the housing is then heated and upset to form the second flange.

The housing is placed in a Toledo press to shear clearance for the spring seat U-bolt and another press operation restrikes the banjo face on one side to flatten out the reinforcing ring. The housing cover, a sheet metal stamping, is then tacked on the opposite side, and the spring seats which are also small stamped parts, are projection welded to the tubular sections one at a time.

The housing is then mounted on a rotating fixture while the cover on one side and the reinforcing ring at the other side are securely fused in place by automatic arc welders. The parts are returned to the conveyor and pass a number of inspection and repair booths which are used to complete any welds which were not made entirely tight by the automatic operations.

On leaving these booths, the ends of the housing are sealed while 5 lb. of water pressure is applied inside to make sure that all welded joints are tight. After straightening and inspecting the axle housings are carried by conveyor to the spray booth where they are painted prior to leaving the department. This production set-up is capable of turning out 200 units an hour; for 22½ hours; 65 skid loads or 13 trailers of 6 tons each leave the department daily.

All in A Day's Work — 1800 Aluminum Pistons

Permanent molds, plus fully automatic melting and annealing, give 100 per cent hardness control

Molding machines are set in an arc around the discharge end of an open-hearth melting furnace

OVER five million aluminum pistons have been made since November, 1933, by the Amplex Manufacturing Company, division of Chrysler Corporation, in its plant on Lynch Road in Detroit. The set-up for the manufacture of pistons is unusually compact, the department occupying 2,400 sq.ft. of floor space in which 18,000 pistons have been produced in a 24-hr. day.

Chrysler, as it has done in so many things, pioneered a new process of making pistons. It employs a new type of open-hearth furnace for melting aluminum ingots and a large battery of molding machines with permanent molds; the castings are heat-treated so efficiently in a continuous overhead conveyor-type furnace that no piston has ever been rejected because of incorrect hardness, when tested on an automatic Gogan Brinell hardness testing machine.

Aluminum ingots are carefully checked when brought into the plant to make sure that they are of the correct analysis. Melting of the metal is done in an open-hearth furnace which has decided advantages over the rotary tilting type. At the charging end of the furnace is a special housed table, with a covered top, onto which ingots are loaded by the operator. Waste gas from the oil-fired furnace is used to preheat these ingots before they are loaded into the furnace proper.

At the opposite end of the furnace is an open well exposing the aluminum bath from which molders dip hot metal with small special calibrated hand ladles. Temperature of the bath is held within a narrow range, recording pyrometers being used in the control. One open-hearth furnace serves two operators, each of whom runs two molding machines.

Chief aim is to eliminate all impurities from the final product to have high strength, correct hardness and heat-treatment. This has been achieved by specifying proper materials, exercising

There are two operators to a furnace and two molding machines to an operator

Casting completed, the molder operates a lever which hydraulically drops the core and opens the mold

proper laboratory control, using furnaces designed so that no foreign matter can reach the bath, and by expert workmanship.

Molding machines, having cast-iron molds and steel cores, are hydraulically operated. After the piston has been cast, the operator moves a hand lever, and the three-piece core drops down out of the way while the piston pin and the mold open in a horizontal plane so that the work can be removed. Another turn of the lever and the various parts of the machine are brought together again to mold the next casting. Production is 35 piston castings per hour per machine, or 70 for each operator.

The molding machines are stationed in the form of an oval around the outer edge of the department, with the melting furnaces in the center. A monorail overhead conveyor, equipped with special carriers with shelves to hold the castings, passes within reaching distance of the molding machines so that the operators can easily load the castings onto the shelves for passage through the annealing oven. Being overhead, this oven saves floor space. The temperature is automatically regulated, making the annealing operation foolproof from the standpoint of time and temperature. Annealing is done at 400 F., castings taking six hours to pass through the oven.

Two at a time, sprues are cropped in a Toledo press

After the pistons are annealed, an inspector unloads the conveyor, examines the castings and crops the sprues on a Toledo punch press. This is followed by a second inspection and a 100 per cent Brinell hardness test of each piston. A simple spot-facing operation at the sprue end of the casting finishes the job.

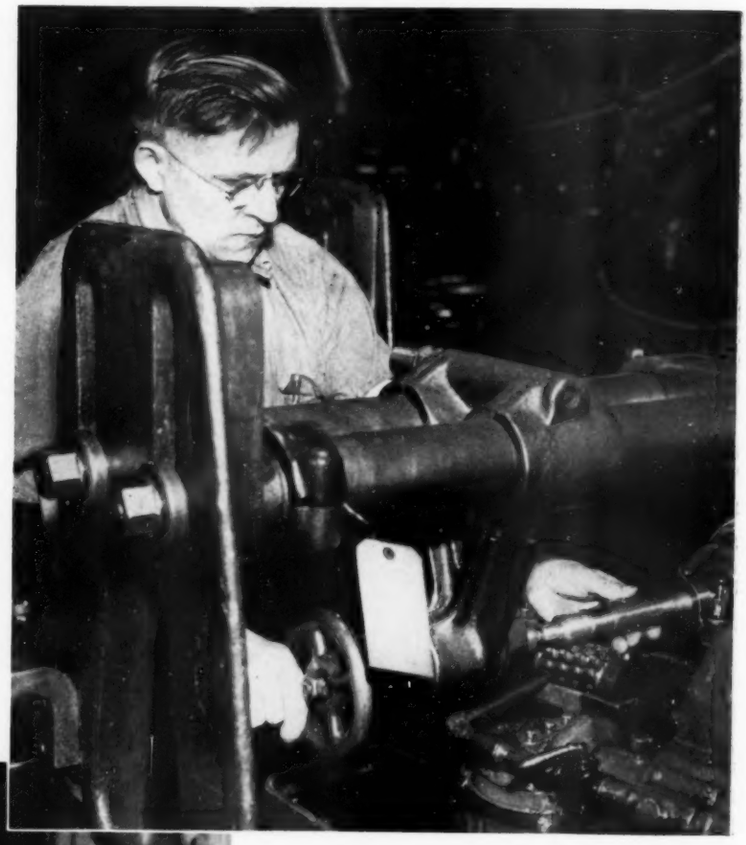
Shop Skill Makes Shifting Easier

Precise gear cutting plus repeated speed tests assure quiet, free-meshing transmissions

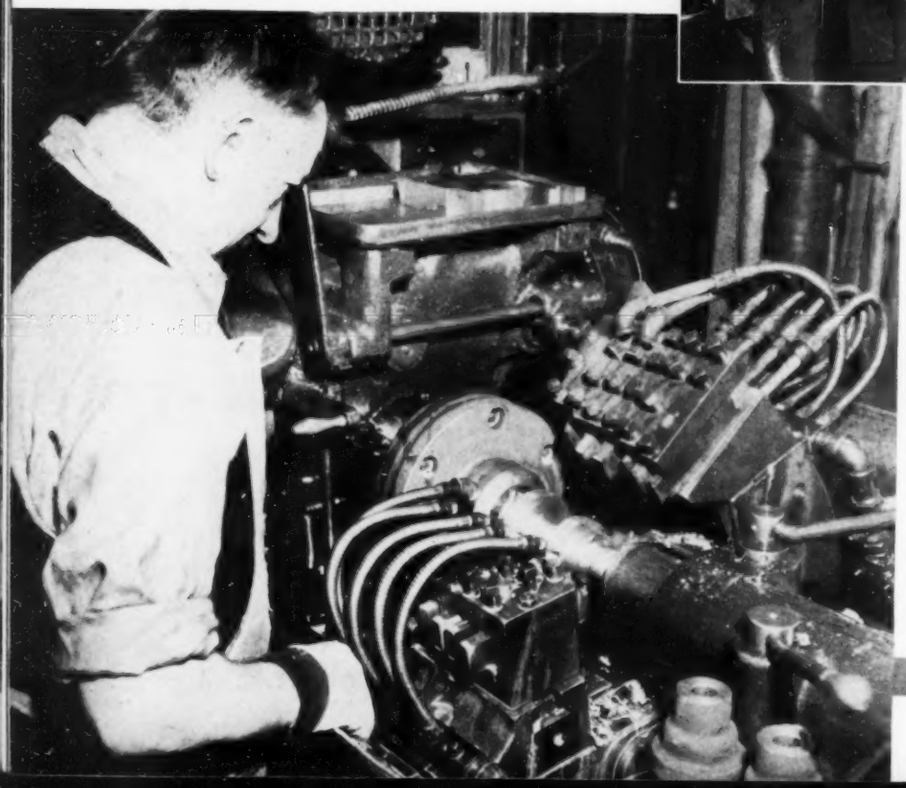
WITH the exception of the overdrive transmission, used on the Airflow models, all the gear sets used on Chrysler Corporation cars are built at the Dodge plant. Here the basic requirements of a good transmission are forever in the minds of the operating personnel. They know that the gears and shafts will be subjected to severe strain in all sorts of weather and that the driver will want them to shift easily under all conditions.

A sturdy design has been developed for this unit with plenty of excess capacity. The materials have been selected for a careful balance between hardness and toughness to resist the grueling service to which they are subjected. As the component parts of these transmissions travel through the shop they are held to extremely close limits to insure the precision of the final product.

Transmission gears and shafts are made of 0.50 carbon, chrome-vanadium steel forgings. The one exception is the small reverse idler gear, made of low carbon alloy steel for carburizing.



Gear blanks are rough and finish turned by multiple-tool set-ups in Fay lathes



A Barber-Colman hobber cuts the helical spline which guides the sliding gear into mesh

● To avoid interference with the clutch teeth, the Fellows machine cuts the transmission drive pinion on the up stroke

● Tooth rounding on a Peerless chamfering machine eliminates sharp corners and aids in gear meshing

Chrysler pioneered the use of the all helical-gear transmission, and this design serves the basis for the current unit. The objective sought is quietness with increased strength. The gears are, of course, the vital part of any transmission so they get great care and attention in cutting and inspecting.

Accuracy begins with the preparation of the blank, because trueness and concentricity in the turning operations is of great assistance in cutting the teeth. Practically all of the parts are done in two Fay lathe set-ups. At one time, multi-tool operations such as these were considered primarily roughing cuts to be followed by a finish cut on centers or on an arbor. These machines have been improved so much in rigidity and accuracy that they now turn out work ready for the grinding operations without subsequent turning.

In general, gear cutting consists in roughing out the blanks in hobbing machines and finishing them in Fellows gear shapers. Both Barber-Colman and Gould & Eberhardt hobbers are used. On the cluster gear, lack of clearance makes it necessary to rough and finish two sets of teeth on Fellows machines. One interesting kink that is used when hobbing some of the gears is to have the upper rim of the blank backed by a small facing tool which shaves off the burrs as they are formed, eliminating a separate burring operation.

After rough cutting and before finish cutting, all teeth are rounded to remove sharp corners and to permit easy sliding into mesh. This work is performed in Peerless gear chamfering machines which run as high as 150 strokes a minute on some of the gears.

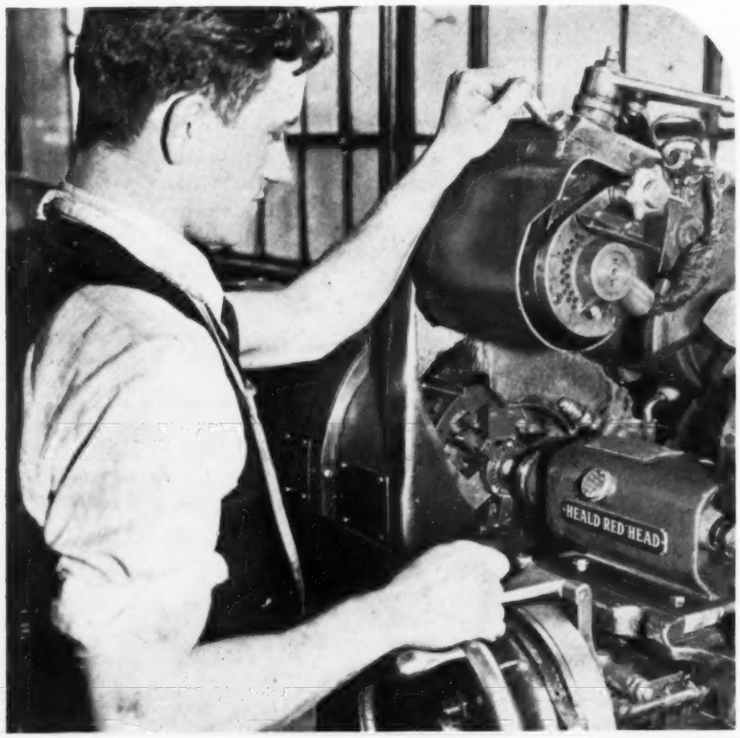
When the design permits the gears are ganged, or set up in groups, for the tooth roughing operation. All finishing of teeth, however, is done one at a time to prevent any possible inaccuracy from slight misalignment due to dirt getting between stacked blanks. Set-ups, such as those for cluster gears,

● **Variations in tools and materials are traced by keeping track of cutter sharpenings**

● **Located from flexible pins between the teeth, the second speed gear is ground internally**

HOB & CUTTER RECORD

DATE	PART NO.	NO. TEETH	PITCH	CUTTER NO.	HEAT LETTER	PIECES PER GRIND	CUTTER THICKNESS BEFORE GRIND	CUTTER THICKNESS AFTER GRIND	AMT. GROUND OFF	REMARKS



where the cutting point must be some distance above the work table, are provided with overarm supports which give added rigidity and reduce any chance of springing or chatter that would mar the finished tooth.

Particular attention is paid to cutters which are sent back to the tool room for sharpening at stated intervals. A "Hob and Cutter Record" is kept of each tool by means of which it can be quickly determined whether a shorter life between grinds is caused by the material cut or a variation in the tool itself.

All through the manufacture of transmission gears at the Dodge plant a check for quietness is made; a careful inspection for accuracy follows each machining operation, and in addition, actual running tests are made of the gears under load.

After the gears are cut, they are given a 100 per cent inspection in which run out is checked and held to within 0.001 in. Gears are selected from the start of each new set-up for a run on the "soft" speeding machine. First they are run against a master and then with their mates to make sure that they are not noisy. They are also inspected for involute profile and lead on Fellows machines. In addition they are put on a Red Liner which is a quick graphical method of detecting any difference in the gears before and after hardening.

This is merely a spot check to make certain that the tooth cutting machine set-ups are correct and is made before the teeth are burnished. Burnishing is done to smooth out tool marks before the gears are hardened, and is carried out for only 2½ sec. in each direction

● **Tool marks are removed and smooth contours assured by finishing the cluster gear on a Fellows lapping machine**

under 100-lb. pressure; Cincinnati gear burnishing machines are used for this purpose.

Gears are hardened and then ground according to the design requirements of each individual part. The sliding gear, which has a helical spline in the bore, is hard broached in an American vertical broaching machine with the work supported on ball bearings which permit it freely to follow the lead of the broaching tool.

Gears which are ground in the bore are checked with three jaws using three flexible shaft rollers located near the pitch line of the teeth. These flexible rollers conform to the curve of the helical teeth and insure that the bore will be ground concentric with the pitch line of the teeth to 0.001 in. indicator readings. Heald Gagematic machines are used for the grinding operation.

When all grinding is completed, gears are given a 100 per cent check on gear speeders for noise caused by mutilation of the teeth. Burrs and high spots are removed by hand grinding to insure against damage to the laps. This is followed by lapping, for which 48 Fellows machines are employed. In this process, each gear is held between three cast iron laps and is run first in one direction and then in the other on an automatically controlled time cycle. The purpose of this operation is to give a fine smooth finish which eliminates slight irregularities caused by the hardening heat.

Final Check for Noise

After the lapping, gears are cleaned first in Sunoco spirits and then in a steam cabinet through which they are carried on a conveyor. They then go into an inspection room where they are put through another speed test in a noiseproof room as a final check for quietness before assembly. They are then checked for backlash. The sliding gear is fitted to the spline shaft by selective assembly, the synchronizing cones are lapped and the clutch units are put together in an alignment fixture.

Assembly from here on follows well accepted automotive practice with the gear boxes carried down a line on a conveyor and the parts fed in laterally, in subassemblies where necessary. The conveyor leads into another noiseproof room where the completed transmission is hooked up to an electric motor and run at speeds up to 3,000 r.p.m. Gears are shifted at this speed as a final check on the quiet, smooth operation of the transmission unit.

● Sprayed-on red lead indicates the bearing when gears are checked for noise on the speeding machine

● Fitted into the box at the final assembly line, the many parts blend into a smooth running transmission

More Cars Per Square Foot at Plymouth

Eccentric spindles grind six valve seats simultaneously in a Hall hydraulic machine

PLYMOUTH Division of Chrysler Corporation has aptly been termed a "record breaker by habit." Its steady rise during depression years has been phenomenal. Today its major operations center in its huge plant at Detroit, which is the largest automobile factory under one roof and which produces more cars than any other single plant in the industry. Parts are manufactured in this plant not only for cars assembled there, but also for cars assembled at branch factories at Evansville, Ind., and Los Angeles, Calif.

Plymouth's Detroit factory, containing 1,000,000 sq.ft. of space, is all on one floor, half a mile long. No other plant builds so many cars in the same area. The two assembly lines are the longest in the industry, with the most workmen along them. Together they can turn out over 170 cars an hour, or better than three a minute.

When Chrysler Corporation boldly invaded the low-price field with its Plymouth, it knew that it must secure mass production of a quality product at an economical cost so that it could price its cars competitively. The Plymouth plant, therefore, was set up with high quality and low cost as objectives. These have been attained through the use of modern precision equipment and of an overhead monorail transportation system which carries parts and materials rapidly from one point to another and keeps floors free from stock awaiting assembly. There are more than eighteen miles of conveyors, all interlocking with the final assembly lines. Materials move simultaneously on 10,000 overhead trolleys.

Plymouth builds all the engines for its cars, including cylinder blocks, pistons, crankshafts, connecting rods, flywheels and camshafts. It finishes all sheet steel parts, such as fenders, radiator shells and hoods; these are cleaned, rust-proofed and spray painted with synthetic enamel in hydro-filter spray booths of new design which enable operators to work without protection of masks, since fumes are carried away immediately and a supply of

Pads on the cylinder blocks are machined in a Cincinnati horizontal surface broach

Eighteen miles of conveyor and the world's longest assembly lines help keep down cost in a highly competitive price class

fresh air is constantly flowing into the booths.

Bodies enter the plant trimmed and painted, but on the way to the final assembly line are striped and polished. The two body lines are at right angles to the two final assembly lines, bodies being taken rapidly from the body lines to the final assembly lines by special electric cranes which operate on overhead monorail conveyors. In fact, all sub-assemblies move crosswise of the plant toward the final assembly lines. In cases where sub-assemblies are completed at some distance from the assembly lines, finished parts are hung on overhead conveyors and carried to the assembly point.

Lifting Is Mechanical

Every attention has been given to the comfort of the workers. Machines are of the type which facilitate the operators' work. Wherever heavy work is done, hoists and other mechanical handling facilities are installed. Cylinder blocks move from machine to machine on a roller conveyor which relieves workmen of the necessity for lifting them. Work is brought within reach of operators in all departments by means of conveyors.

Along the cylinder block line are many machines of unusual design and high efficiency. Cylinder bores are semi-finish and finish bored on an Ingersoll six-spindle boring machine, the cylinder head studs being in the block at the time this work is done. With the studs in place, it is possible in the machining operations to secure better, more accurate and rounder holes. The Ingersoll machine is of the vertical type employing the stub bar boring principle. Twelve angular holes are drilled in the valve tappet boss and the top of the valve tappet holes chamfered on a Baush two-way all-electric drilling machine.

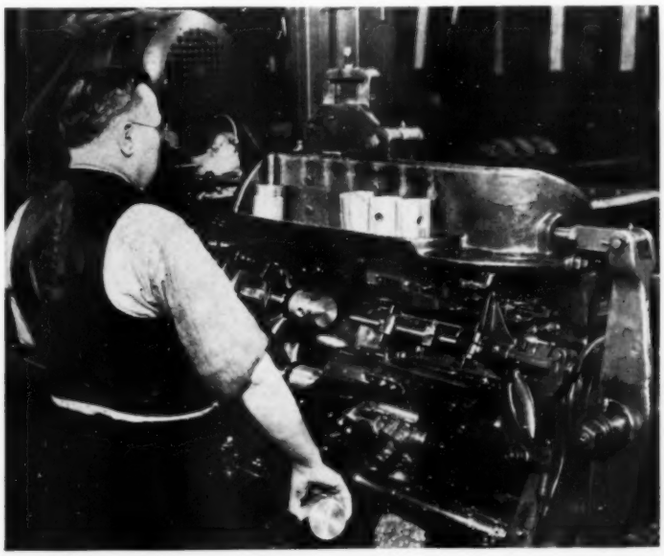
All valve and tappet holes and the oil filler side of the block are drilled on a Natco center-column combination drilling machine. The same type of machine drills, redrills and countersinks the holes in the bottom and manifold side of the block. A two-way horizontal combination Natco drilling machine is used to core drill, rough and finish bore the crank and cam holes in the block and counterbore the welch plug hole in the rear and front ends. Still another Natco machine, a two-way driller and tapper, does the work of drilling, counterboring, reaming and spot facing the distributor hole and the oil pump hole in the block and drilling, countersinking and tapping the screw holes. Cylinder bores are honed on a six-spindle Barnes honing machine equipped with Micromatic hones. All of these machines turn out work of remarkable accuracy and precision.

Valve Seats Are Ground

Six valve seats in the Plymouth cylinder block are ground simultaneously on Hall eccentric multiple-spindle valve seat grinders of new design. Three of the valve seats are intakes and three exhausts, the latter being of the hardened steel type. Grinding wheels, therefore, are of a different grit and hardness, but the grinding time is the same, regardless of whether the seat is cast iron or hardened steel.

The distance that the seats are ground is regulated in relation to the face of the block where the depth feed stops or contacts. The machine is lowered and all spindles telescope the pilots, which are inserted before the cylinder block reaches the machine.

All valve seats before they come to



● **Pistons are turned in a Baird six-spindle chucking machine**

● **A double-end Ex-Cell-O precision boring machine diamond bores the wristpin holes**

Wristpin holes in aluminum pistons are core drilled, chamfered and reamed, and the wire retainer groove is undercut in a special two-way machine

this machine are held to within a depth of 0.004 in. of each other, insuring the fact that all six seats will be ground true not to exceed 0.001 in. Since the grinding wheels run at a speed of 9400 r.p.m., the correct grinding wheel must be used or the wheels will load, causing the seats to burn. Experiments so far have been successful in securing proper wheels for this work. The eccentric shaft in the grinding machine runs at 32 r.p.m. and the outer high-speed shaft, surrounding the inner eccentric shaft, at 9400 r.p.m. Spindles have an eccentric action.

High-cycle motors are employed. The gearing mechanism runs in a bath of oil, being constantly sprayed by an oil pump. The entire set of gear boxes, motors and spindles, together with the diamond dresser, raise or lower on a set of ways. A special dressing fixture is supplied to take the place of the cylinder block in dressing the wheels. It fits onto the dowel locating pins, bringing the pilots for the spindles to perfect alignment and to centers which do not vary over 0.001 in. This permits the operator to dress all the wheels the same.

The diamond dresser has a suction housing attached to it which sucks the abrasive away when dressing the wheels, protecting the spindles from undue wear. Grinding wheels must be dressed every 20 to 30 blocks. Although gear boxes have spindles set at definite centers, in case of a change in models to other new valve guide centers, they can be changed over at small cost. So far as accuracy is concerned in the operation of the machine, the human element has been eliminated. There is no motor torque to push the pilot over and no offset weight to cause the pilot to bend. High finish is obtained by use of this machine. Six seats can be ground in 26 to 30 sec.

For high production and precision of workmanship, it would be difficult to find a machining department anywhere which surpasses the aluminum piston department at Plymouth. In a floor space of only 5,630 sq.ft., some 18,000 pistons are machined each working day.

To compensate for the difference in expansion of a piston when heated across the axis through pin holes and the axis at right angles to this, it is necessary to grind a relief on the piston in line with the pin holes. In the Plymouth plant elliptical pistons are ground on a Cincinnati No. 2 centerless grinder. This machine has an infeed attachment equipped with a special regulating wheel housing which gives the desired movement to grind the piston elliptical and a special work drive positively timed in relation to the rotation of the regulating wheel. The regulating wheel is of steel and is in effect a master cam governing the contour of the piston. Since the circumference of the regulating wheel is three times that of the piston, its contour forms six "lobes" and six "recesses." The "lobes" on the regulating wheel shorten the distance between the regulating wheel and the grinding wheel, causing reliefs to be ground 180 deg. apart on the piston, to give the desired clearance.

In order that the relief will always be ground on the axis through the pin holes (and in order to prevent slippage in the relative angular positions of the piston and the regulating wheel), the piston must be positively located and driven. This is done by having a positive drive directly connected with the drive of the regulating wheel, the drive turning a fork, the rotary speed of which is three times that of the regulating wheel. This fork fits snugly

Clamped by air, pistons are brought within two grams of standard weight by a Snyder weighing machine

over a special pin placed through the pin holes of the piston and rotates the piston three times each rotation of the regulating wheel.

The work driver is engaged and disengaged through a single finger clutch; therefore, when the cycle is begun and when the clutch automatically engages, it starts the work driver revolving at a certain point with reference to the regulating wheel. To guarantee a constant pressure between the regulating wheel and the piston, a pressure roller is utilized exerting a force on the piston at all times.

The operating cycle, from the time when a piston is finished to the corresponding point on the next piston, is as follows: the infeed attachment withdraws the slide bearing the regulating wheel and housing from the work. When the regulating wheel is withdrawn, the ejector cam in the infeed attachment, which on standard machines is used to eject the work, disengages the single finger clutch and stops the positive drive mechanism. The operator removes the finished piston and places another on the fork and two blades. A switch is pressed, starting the infeed attachment. The ejector cam releases the single finger clutch and the positive drive unit engages. The automatic infeed attachment feeds in the slide until the piston is finished, retracts the slide, and the same cycle is repeated. The entire cycle is rapid, each centerless grinder turning out over 300 units per hr.

To slit a horizontal slot into the lower ring groove of pistons and a vertical slot into the skirt, Plymouth uses a Snyder single-purpose machine of special design. It has two individual spindles, one vertical and one horizontal, mounted on ball bearings, with individual motor drives and pick-off change gears inclosed in separate housings. These two housings are mounted on a sliding table and arranged with adjusting screws for depth of cut in relation to each other, allowing for the regrinding of cutters.

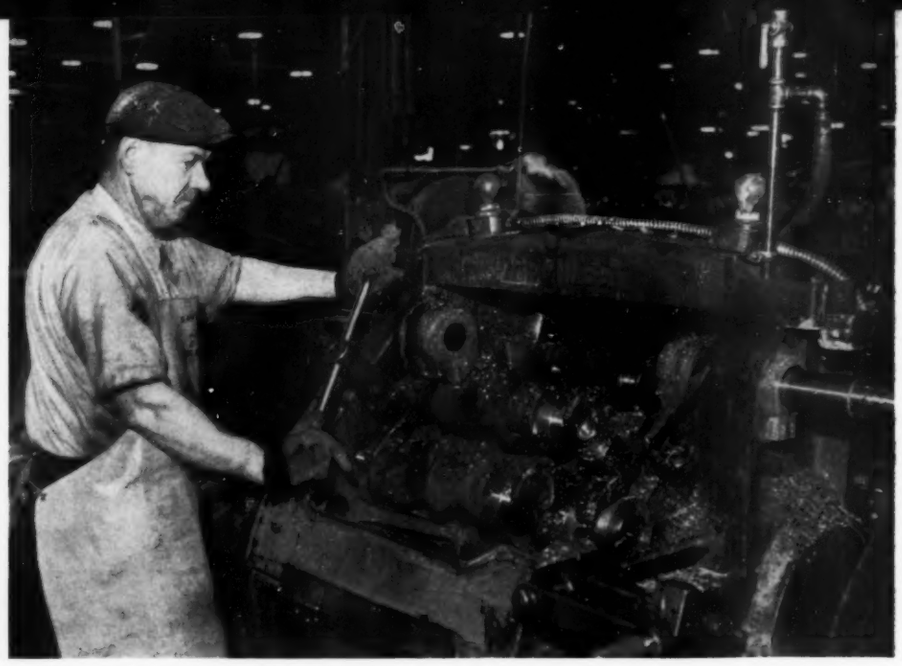
One for the clutch side and one for the crank side, two Gisholt Simplimatics turn and face cast iron flywheels

The cycle of operation, counterclockwise rotation, is as follows: after the index plunger is released, the hydraulic system is started and the slide carrying the two spindles rapidly approaches the work. It feeds into a predetermined stop, cutting the horizontal slot into the lower ring groove, rapidly reverses and stops. The index plunger is released to index the table, at the same time cocking the hydraulic system, and with a spring pressure the index plunger is forced into the next index hole of the rotary table top, actuating the hydraulic system automatically again and cutting the vertical slot into the skirt. After the table is filled, the two cuts are simultaneous, a completed piston being produced at each pass. Disregarding the loading, the hydraulic system can make a cycle in three seconds. Production of the machine is 600 pistons per hour.

With a P. & W. Electrolimit gage the operator checks the O.D. and grades the pistons

Four-Station Turning

The outside diameter, the dome and the ring grooves of the pistons are rough and finish turned on a Baird six-spindle horizontal automatic chucking machine. There are four stations, the front and rear cross slides serving the first and third work stations respectively and the double front and rear cross slides serving the first and second and the third and fourth work stations respectively. The four-station cross slide serves all four stations. The diameter and dome turning tools recede from the work at the completion of



Front and rear ends of the crankshaft are drilled, redrilled, chamfered, counterbored and tapped in a Greenlee six-station machine

the work stroke, so that no tool marks are left on the piston and no further finishing of the dome surface is required.

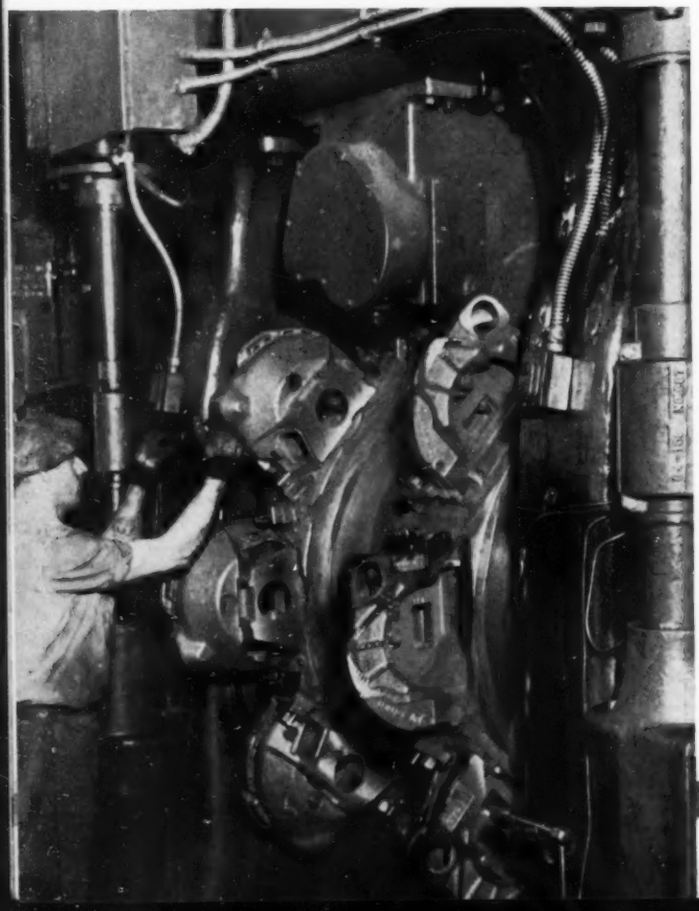
Piston wristpin holes are core drilled and chamfered, the lock ring grooved and the holes semi-finish reamed on a Snyder double-end piston machine. There is a four-station, hand-indexed fixture which holds two pistons in each station. The piston is located with the skirt end down, being squared up on spring V's and clamped with a cam clamp on the head end. The machine is powered with self-contained 5-hp. hydraulic units on each end. Motors are mounted in the bed on spring plates to eliminate vibration. Two pistons are loaded at the first station. At the second station the core drilling and chamfering work is done and at the third station the lock ring is grooved. The last operation is to semi-finish ream. Although line reaming is not done, the two bores are held in line within 0.0005 in. The machine turns out 500 pistons per hour.

Twelve holes ⅛ in. in diameter are drilled in the third ring groove of the piston on an Ex-Cell-O 12-spindle drilling machine. The wristpin hole is rough and finish diamond bored on an Ex-Cell-O double-end junior precision boring machine.

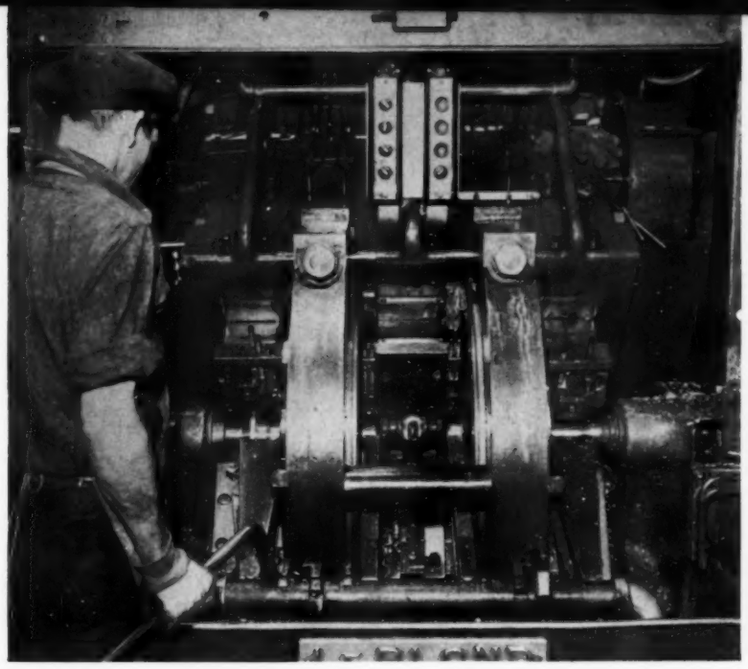
Pistons are weighed and machined to exact specifications on a special Snyder machine powered with cam feed units which are mounted inside the machine bed on a sub-base with a vertical adjustment. The "Exact Weight" scale is provided with an extension to hold a piston pot chuck which is clamped with an air cylinder. The cutter feeds up and rapidly reverses. Pistons are held to a constant weight of plus or minus two grams. Such practice enables Plymouth to cut down its bank of finished parts and eliminates the necessity for selecting pistons of similar weight, since all pistons are approximately the same weight.

Every piston has the wristpin bores checked and is graded by variations in outside diameter on a battery of Pratt & Whitney electro-limit gages. These gages do not have moving parts and are free from vibration, dirt and dust so that they can be used in continuous production without fear of interruption in their efficient service. Large scales for fine tolerances eliminate eye fatigue and insure accuracy while inspection is proceeding at full speed. The machines are foolproof so that they will record accurately the grading and measurement of pistons while being operated by unskilled help.

In grading pistons to match the



Clutch housings are rough and finish faced on both sides in a Newton drum-type miller



A Le Blond double center-drive lathe is used for turning the crankshaft bearings and flange

bores, the meter of the gage shows clearly the zones for grade selection. There are partitions on the table in front of the operator. After grading, pistons are put by hand into the proper compartment as indicated by the gage. Machines are so designed that readings are taken with a measuring pressure of only four ounces. The operator, in checking the wristpin bore, gets a reading within a scale on the dial of 0.004 in. The hole is held within 0.0002 in. Amplification on the scale is 5000 to 1, since one-tenth on the product is equal to a scale reading of one-half inch on the dial.

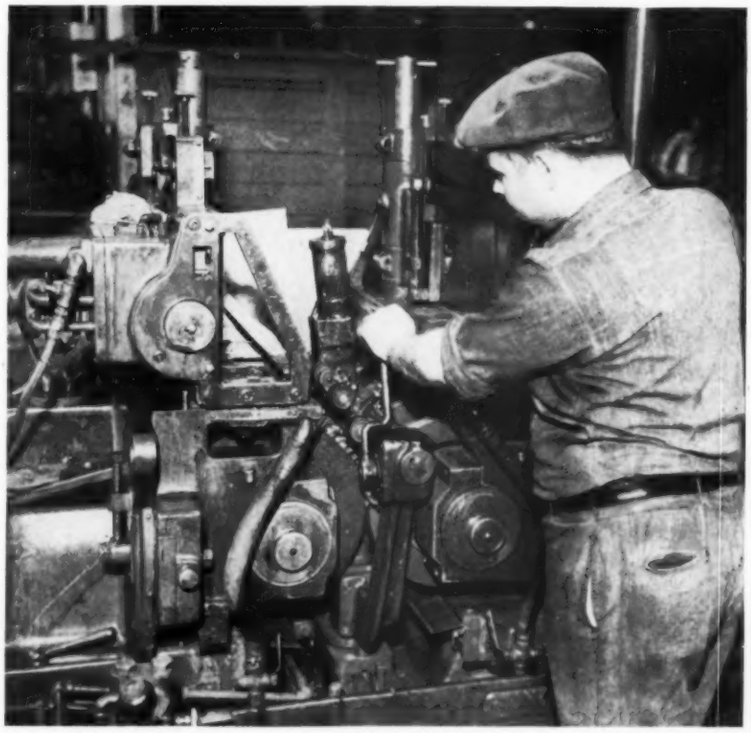
One of the most interesting installations at Plymouth is a battery of two heavy-duty Gisholt "Simplimatic" lathes for turning and facing cast iron flywheels. These two machines produce 40 pieces per hour, one machine doing the machining on the clutch side and the other on the crank side. The cycle of operation is automatic. A detailed description of these operations has been previously published (*AM*—Vol. 80, page 280).

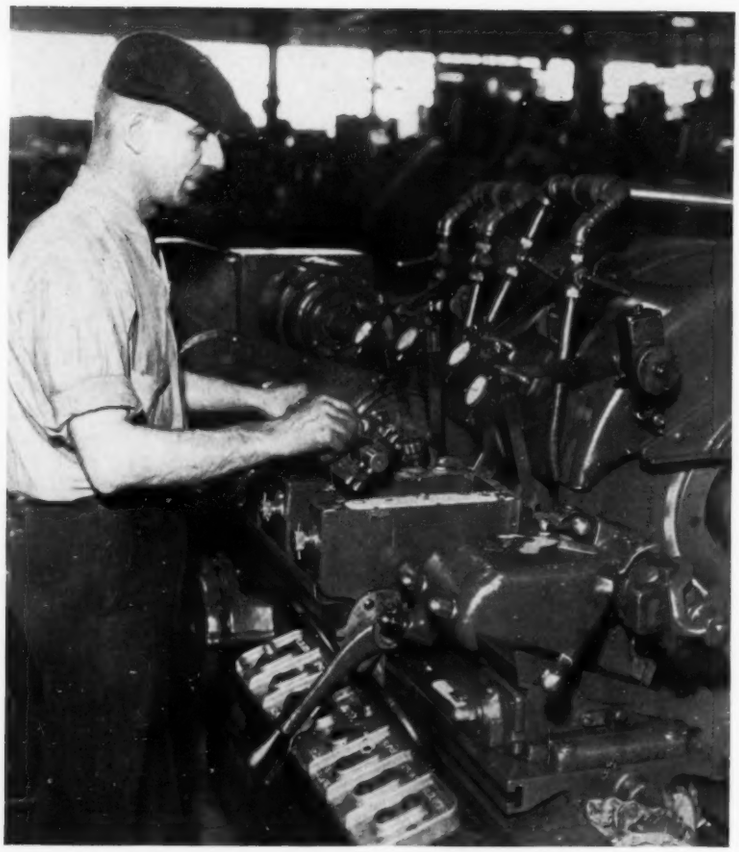
A number of drilling, counterboring, chamfering and reaming operations are performed on the forged steel crankshaft on a Greenlee two-way crankshaft drilling machine. The machine has six stations, two crankshafts being loaded at a time and held in position by a clamp strap. It is built on a heavy, one-piece base, with ways 24 in. wide and 58 in. long which carry the two hydraulic feed units. The multiple-spindle heads are mounted on them.

Four bearing diameters of the cast iron camshaft are simultaneously lapped on a single-purpose centerless lapping machine. Two ten-thousandths of an inch of stock is removed by this operation. Bearings are held round within 0.0005 in. and straight within 0.0001 in. The machine consists of a base upon which are mounted the housings for supporting the lapping wheels. The housings in which the wheel spindles are mounted can be swiveled in vertical planes in much the same manner as the regulating wheel housings of centerless grinders. Provision is made for driving the wheels at variable speeds. The work rest, mounted between the wheels, supports the work while passing longitudinally through the machine. Over each wheel is placed a hydraulically-operated wheel truing device so that the wheels can be trued to the proper contour, as determined by the angular setting. This contour in effect permits the wheel to wrap around the work passing through the machine, thus obtaining a true lapping action. Advantages of the centerless lapping operation are the high quality of surface finish produced, the use of solid abrasive wheels which keep the work clean, and the fact that production is practically continuous. At Plymouth the machine handles 120 camshafts per hour.

For finish grinding the outside diameter of Nos. 1, 2, 3 and 4 bearings on the camshaft, a Norton hydraulic semi-automatic camshaft grinding machine is used. All the operator does is to load the machine and start the automatic cycle by pressing a push button and moving a single lever. The four wheels grind the bearings simultaneously in about 30 seconds. Push

At the rate of 120 an hour, Plymouth camshafts are lapped on four bearings to within half a thousandth





A limit gage is used to check the O.D. of cast iron camshaft bearings after grinding

buttons provide individual control of the various units. Even the steady-rests operate automatically.

Plymouth was one of the first plants in the country to adopt surface broaching on a sizable scale. At present it is being used on eight parts and thirteen operations. One of the first applications was to broach the four bearing cap surfaces of the cylinder block on a Cincinnati hydraulic horizontal broaching machine. A new Cincinnati machine has recently been installed for this job. It has several interesting features. It is the first time that a torque motor has been used for raising and lowering the fixture and then clamping the work in place. A special vacuum cleaner arrangement has been provided for removing all chips and cast iron dust. The machine has an all-welded steel bed. Production is about 110 blocks per hour.

The sides of bolt bosses and the bolt head seat on the connecting rods are broached on a 60-in. Foote-Burt continuous surface broaching machine. The joint face and the diameter of the rod are surface broached on a 70-in. Foote-Burt machine. A similar machine is employed for broaching the joint face and diameter of the connecting rod cap.

Crank ends of the connecting rods are finished on a two-spindle vertical surface grinder

Finish Gives the Final Touch

Following the system of straight line production, fenders enter the vapor degreasing machine on a monorail conveyor

THE MAN WHO BUYS a new car today is getting a product which will stand up under the rigors of all sorts of weather and still look well, provided he takes reasonably good care of it. The paint job is far superior to that of a few years ago, giving the car a high luster and smart appearance over a long period of time. Bodies, fenders and other sheet-metal parts are protected from rusting.

These advantages to the car owner are traceable to the greatly improved technique of finishing sheet-steel parts. Chrysler has been in the front rank in the adoption of new finishing methods, from the smoothing and polishing of the metal "in the white" on to the cleaning and rust-proofing processes and thence through the enameling or lacquer stages.

An outstanding achievement has been installation of the latest type of spray booths along with a paint recirculating and reclaiming system at three of the corporation's plants—Plymouth, Dodge Main Plant and the truck plant. Equipment at the Dodge Main Plant is the largest of its kind in the industry. It consists of three lines of Mahon "hydro-filter" spray booths for the painting of bodies. Booths are arranged for straight-line production, bodies traveling on a drag-chain conveyor directly from the booths into baking ovens.

Filtered air is forced into a space above the perforated ceiling of the spray booths. This, together with the suction at the inlets to the "hydro-filter" units located near the floor, provides a continuous down current of fresh air. Fumes from spray guns thus are carried down and out of the booths and workmen get a constant supply of fresh, clean air. Air is taken into the plant by an elaborate arrangement of filtering equipment on the roof.

Each Chrysler plant which does enameling and lacquering work has a paint circulating system which carries the enamel or lacquer from a central mixing room by pipes to the individual spray booths. This method, as against the older practice of maintaining small containers of paint in each booth, insures a better paint job on automobiles at lower cost.

Concentration of paint mixing in one spot means proper mixing and continuous agitation of paint at all times. By the use of hydrostatic gages on mixing tanks, paint viscosity is accurately controlled and paint can be mixed on a weight basis instead of by volume. Possibilities of off color paint are practically eliminated. The greater the quantity mixed, the less likelihood for off-color. Material pressure regulators insure uniform and accurate gun pressure at the spray booths at all times.

Because the spray gun pressure can be controlled, the film thickness of the finish coat can be held uniform in relation to the line speed by establishing the exact pressure required at a given speed. The foreman of the paint line is responsible for such regulation. Paint is available at all spray booths at all times in case a change is made in the color to meet production line requirements.

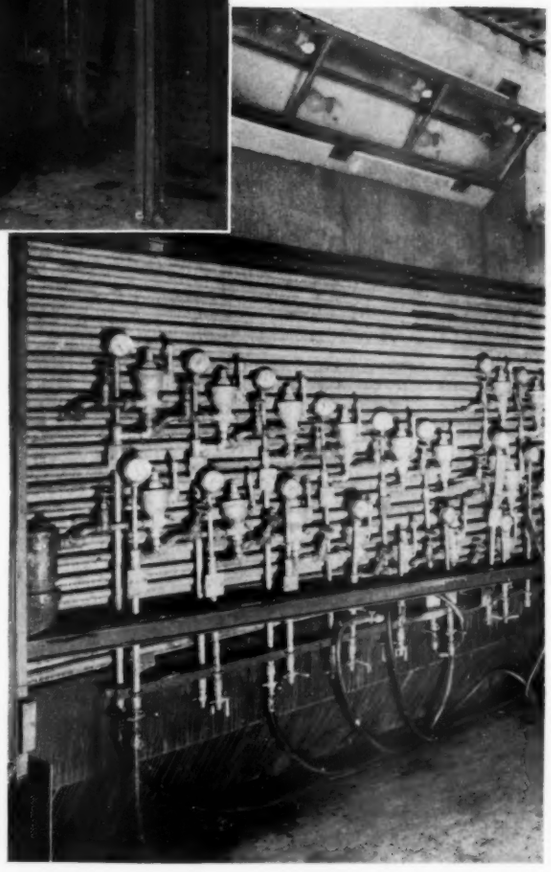
The paint circulating system results in impressive savings. Most of the paint is retained in storage tanks in fireproof mixing rooms, only 2.3 gallons per 100 ft. of ¾-in. pipe being in circulation. Trucking and other handling of paint to and from booths is eliminated. There is no need for continual refilling of small containers in each spray booth. The cost of cleaning dirty containers is saved. Occupancy of floor space is reduced. Loss of thinner by evaporation in mixing paint is cut down substantially. In addition, the plant is kept cleaner, and there is maximum fire protection.

In several Chrysler plants induction type ovens are being used to bake enamel on steel parts. An outstanding example is the installation at the Plymouth plant, where the time required for baking has been reduced 25 to 30 per cent, and the quality of the finish has been improved. Maintenance expense for these ovens is surprisingly small, for there is little if any deterioration of equipment and materials.

The principle used is to pass the

Mixed at a central plant, paint is distributed by pipes to spray booths throughout the plant

A variety of paints spray booth; air



freshly painted steel parts to be baked through the center of a series of coils carrying high frequency electric current. A secondary current is set up in the steel wheels and thus the enamel is baked on at an even temperature. Since the paint is dried from the inside to the outside, it leaves a firm, dense film free from holes or wrinkles.

Ovens consist of the conventional tunnel of insulated wall material with an overhead chain conveyor running through it with the steel parts. The conveyor chain is of bronze and the rails of aluminum. Side walls are of hollow metal panels packed with insulation, or of fibre board. Ovens are of the modified "A" type which makes an air seal, improving thermal efficiency and the working conditions at either end.

Steel parts passing through the first coils are heated rapidly to that temperature required for baking, after which the parts pass into weaker coils where the power input to the parts balances the radiation, the result being that the parts are maintained at a temperature 75 to 80 F. hotter than the air surrounding them, with only a small power input, thereby accomplishing a major economy.

What is believed to be the largest installation anywhere of metal degreasing equipment for cleaning sheet steel is located at the main plant of the Dodge Division. Fenders and other sheet metal parts are cleaned by passage through a "Detrex" degreasing machine of the vapor type. The machine has two monorail conveyors so that two lines of work move through it at one time; it is completely automatic and is arranged for straight-line production.

Sheet-metal parts are transported through a fog of pure solvent vapors. The height of the vapors is controlled by a water jacket about 8 ft. above the floor in the walls around the machine, vapors thus being held within the machine itself. The vapors condense on the cool metal, dissolving the oil and grease. The flow of the condensed solvent on the work carries off solid particles of dirt as well as oil and grease.

The degreaser is steam-heated and is equipped with a continuous still for cleaning the solvent. The still's capacity is 50 gal. of clean solvent an hour. Within the machine about 250 gal. of solvent is distilled each hour. Use of the still decreases the frequency of cleaning the machine and simplifies the operation. The machine is insulated with paneled mineral wool below the water jacket, thus resulting in important economies.

The degreasing unit is 65 ft. 5 in. long, 10 ft. 5 in. wide and 19 ft. 4⅜ in. high. Normal productive capacity is 17,000 lb. per hour, but as high as nine tons of parts per hour are cleaned at times. The work moves through the machine at a rate of around 20 ft. per minute.

Parts emerge from the degreaser clean, warm and dry. They are immediately taken on the same monorail overhead conveyor through a spra-bonderizing installation where they are given a protective rustproof coating. Bonderite is applied by 170 automatic sprays through which the solution is pumped from a 2,340-gallon tank. After passing through the bonderizing section, parts go successively through a clear water spray rinse, an acidified spray rinse and a drying oven. The various sections of the process are inclosed in continuous sheet metal booths to retain the heat and confine the sprays.

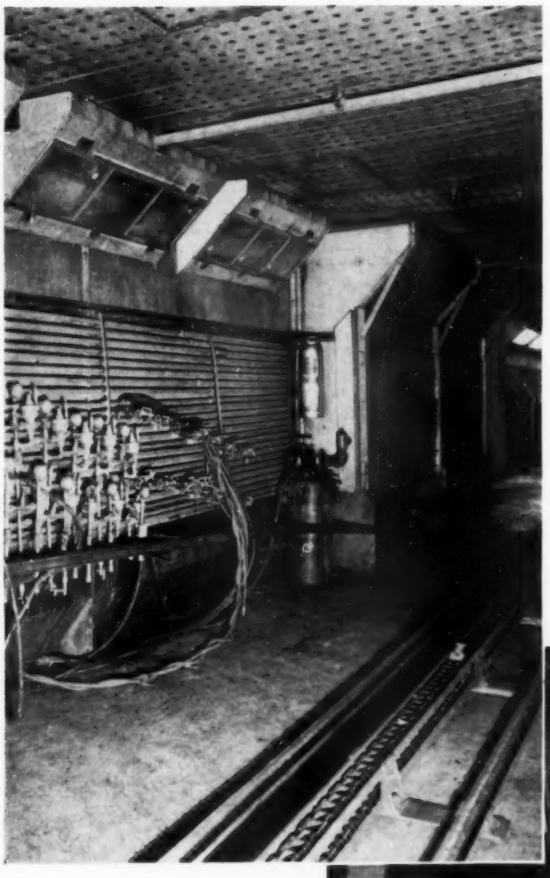
A new method recently developed of rust-proofing steel parts by means of an automatic spraying system has made it advantageous for the Dodge plant to put all bodies through a spra-bonderizing process. Spra-bonderizing chemically produces a typical rust-resistant phosphate coating which provides an adherent base for enamel or lacquer. The process consists of spraying the bonderite solution onto the work as it passes through the bonderizing section of a completely mechanized conveyor line, including cleaning, bonderizing, rinsing and drying. The pressure spraying accelerates the chemical reaction and produces both a cleansing and coating action in one operation. Processing time is about 60 sec. Main advantages are the short processing time, low steam requirements, small floor space needed and processing of a given amount of work with a small volume of solution due to a recirculating system.

Bodies are given a preliminary treatment in the form of two-stage cleaning, consisting of an alkaline wash and a rinse. Then the bodies pass through the bonderite section equipped with 138 rotosprays which throw the solution on every part of the body. The sprays are fed by a pump drawing solution from 2,500-gal. tank. Temperature of the spra-bonderite solution is 170 F. As the spray drips, it is reclaimed, passing back into the storage tank, the chemical concentration being replenished from time to time as indicated by tests of the solution. There are three lines of bodies moving through the bonderizing process, each line having a capacity of 45 bodies per hour.

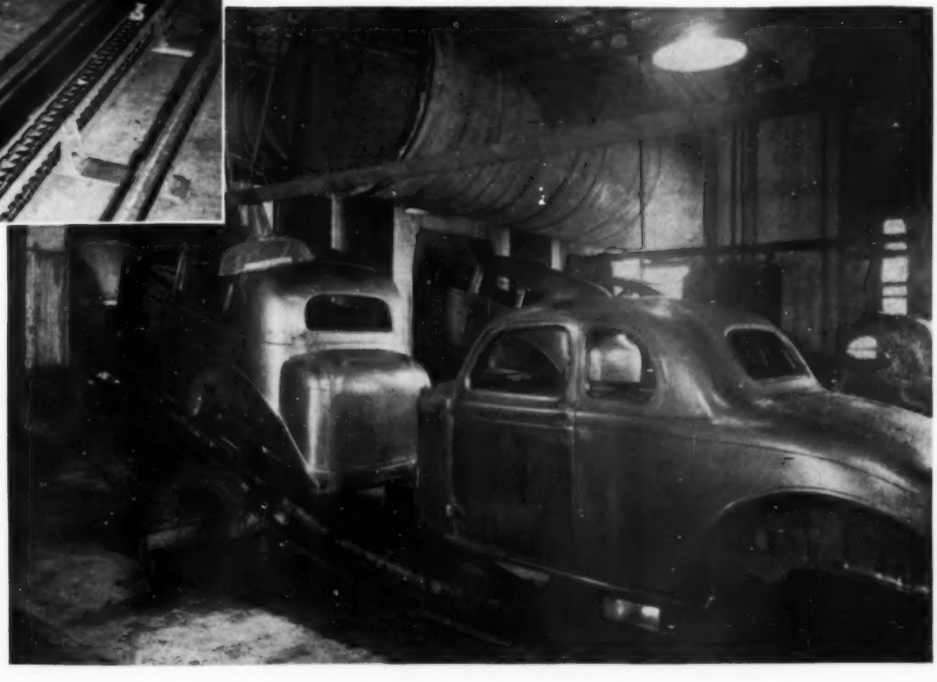
From the bonderizing section the bodies move through a clear water spray rinse, an acidified spray rinse and thence into a drying oven to make sure that all moisture is eliminated from seams, cracks and crevices in the metal.

All Airflow bodies and bodies for Chrysler sixes and eights and De Soto Airstream cars are made rust resistant by similar spra-bonderizing equipment which has been installed at the Kercheval plant of the Corporation.

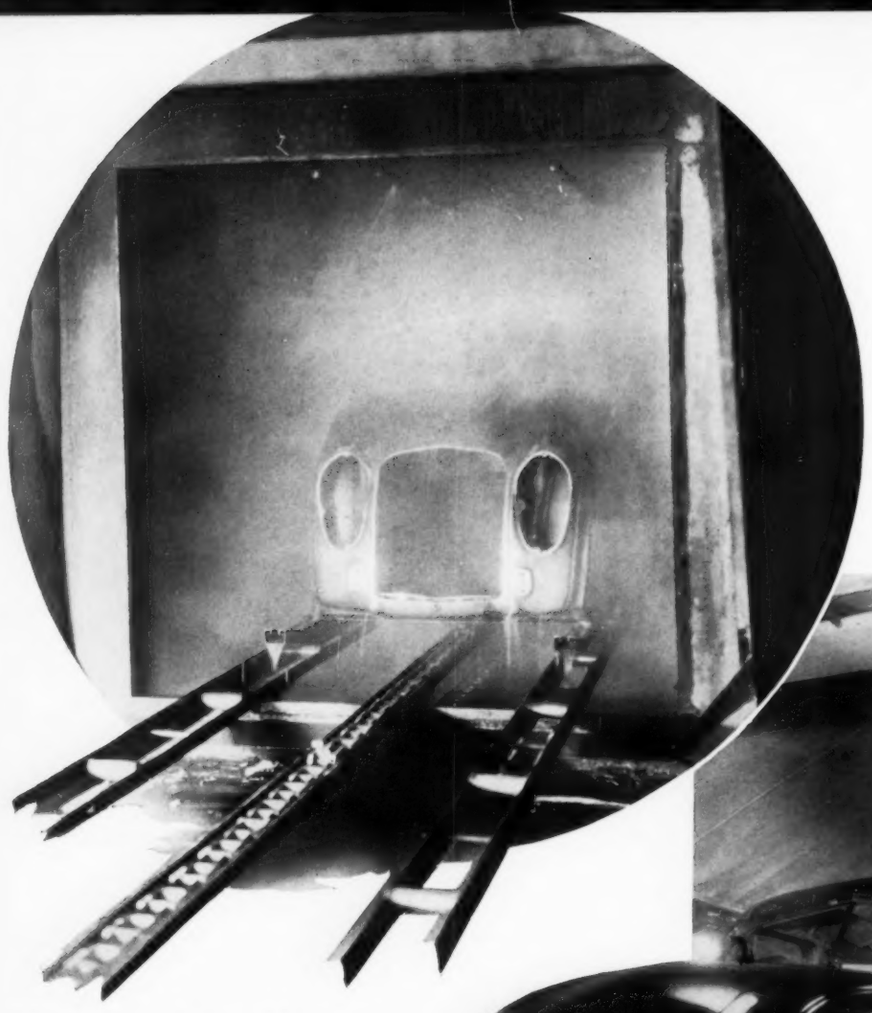
is available in this hydro-filtered enters through the perforated ceiling



An overhead tank supplies solution to the bonderite spray booth for rust proofing bodies



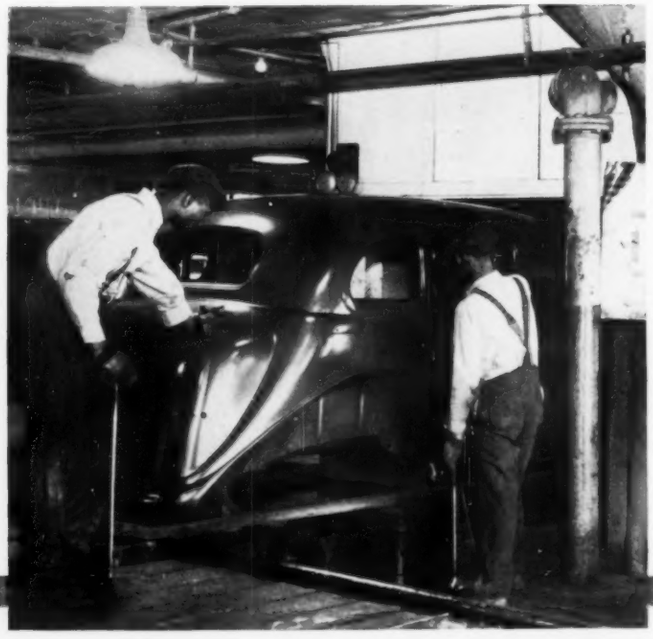
Body

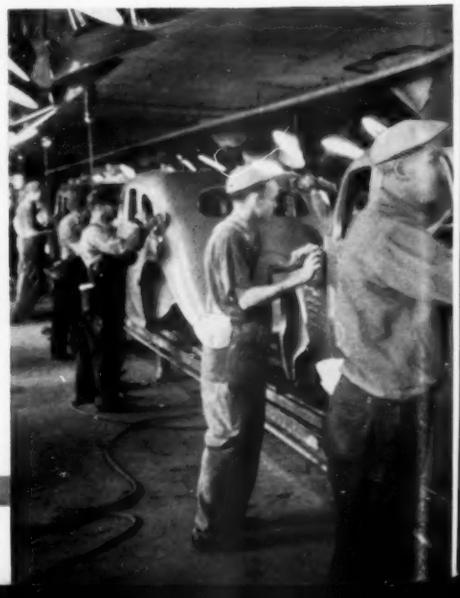


Paint supplied from a central source is applied to the under side of Airflow fenders

● Looming up like a ship in the fog, an Airflow body emerges from the bonderizing booth at the Kercheval plant

● Drag chain conveyors carry the bodies through drying ovens in which the temperature is controlled within two degrees





Methods Break Tradition

CHRYSLER manufactures bodies at its Kercheval plant in Detroit for its Chrysler and De Soto Airflow and Airstream models and some of its Plymouth cars and at its Dodge plant for Dodge and Plymouth passenger cars. Both body plants embody latest improvements in production methods. Since Chrysler uses safety steel bodies in all its divisions, welding is extensively used in body construction. Hydromatic welding, developed by Chrysler and described elsewhere in this issue, is widely applied.

Body and frame are a single unit in the Airflow design. The safety-steel body is trussed with steel girders like a bridge. Passengers ride inside the frame instead of over it, the body forming a protective wall of steel around them. It is claimed that this kind of frame is 40 times more rigid than the conventional type.

Airflow cars are longer than cars of traditional design and hence occupy more manufacturing space than standard cars. The problem which the management of the Kercheval plant had to meet when it began making Airflow bodies was to arrange its facilities and install equipment which would make possible an output of just as many cars in the same length of time as formerly, although each Airflow in process of production took up more space than previous models. The solution was found by introducing new manufacturing practices which break with automotive tradition.

So-called "fresh air curtains" have been draped around spray booths where bodies are painted. These curtains consist of controlled currents of cleaned, filtered and tempered air which vary in thickness from three to six inches. They are forced by fans through rows of vents around the domed ceilings of the booths and flow downward to within a few inches of the floor, where they disintegrate into small currents. These small currents are pulled into the booths and up through openings in the center of the ceilings by additional fans.

This process results in the opening up of spray booths instead of having them closed off, the air curtains forming the partitions between them. Workers thus are protected from fumes. These curtains require 20,000 cu.ft. of filtered air each minute per booth at a temperature of 80 F. Air travels from suction fans to the point of use through large metal conduits.

Air curtains not only ventilate spray booths, but also seal in the heat at the end of drying ovens. They are so effective that the temperature within 2 ft. of the oven is 70 deg., whereas just inside the oven it is 300 deg. This method of regulating the temperature eliminates canvas curtains, sliding doors and other equipment which might injure bodies during the finishing process. It also provides more comfortable working conditions.

There are two types of air conditioning in the Kercheval plant. The first is for low-pressure air, which is heated to 80 F. for air curtains and ventilation. The second is the air used for making or drying various primer, surfacer or lacquer coats, requiring temperatures up to 250 F., and for enamel work up to 400 F. The high-temperature air for these operations is so accurately controlled that the temperature in oven 500 ft. long does not vary more than two degrees from front to back, or top to bottom. Such accuracy in heat control produces the finest undercoat conditions and painted surfaces.

Equipment consists of 196 propane gas burners, 10 intake fans having a total capacity of 1,200,000 cu.ft. per minute, and 114 discharge fans of 10,000 cu.ft. per minute capacity each. The amount of propane gas burned by this plant every 24 hours is equivalent to 2,000,000 cu. ft. of city gas, or enough to supply a city the size of Dayton, Ohio. All air delivered passes through oil filters.

Rear-end assemblies of Airflow bodies are made by welding the two side panels and the rear panel to form what is termed the "balloon" assembly. The two end assemblies are placed in a large fixture and electrically welded together, after which the assembled unit is welded to the bridge-type frame. Various body parts are welded on hydromatic machines which are unusually speedy and which do work of uniform quality.

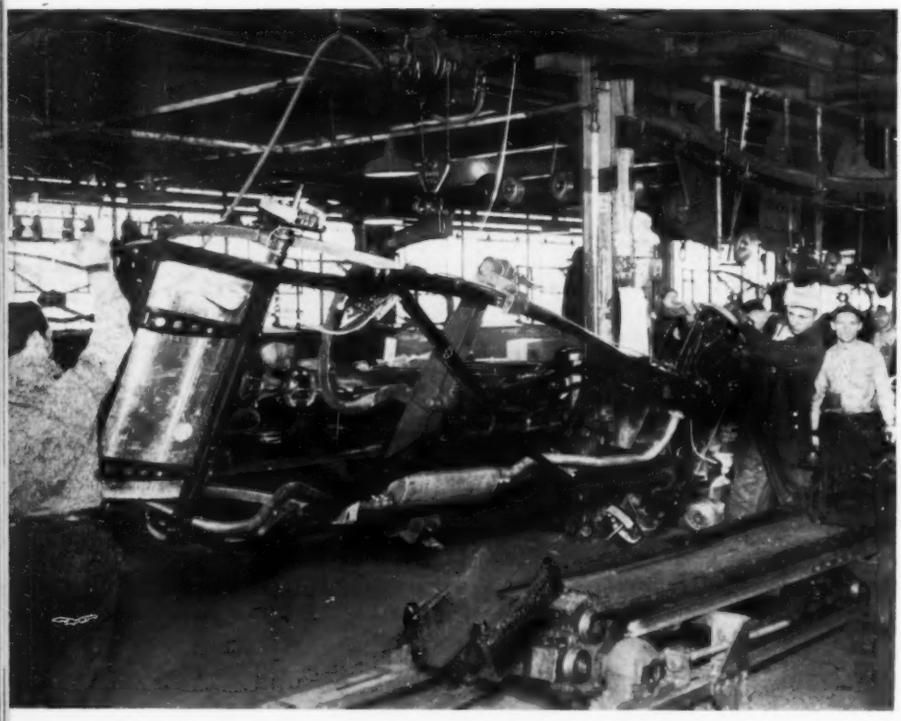
The Dodge body plant is an eight-story building honeycombed with conveyors and in which work progresses from the top floor to the bottom. The work is constantly on a conveyor, the design of which varies according to the requirements of the particular operations. The front-end, or shroud, of the body is finished on an oval-shaped, floor-type conveyor 100 ft. in length. Work on the eighth floor moves along on an overhead conveyor which enables operators to walk around it and get at it from all angles.

In the Dodge body plant is one of the most modern systems in the industry for cleaning, rust-proofing and painting sheet metal parts and entire bodies. It is described in detail in the metal-finishing story in this number.

Shining in their new coats, bodies are given final touches before being transferred to the chassis line

5,000,000 Possible Combinations

Synchronized at Assembly



After being carried along the line upside down for operations on the under side the chassis is inverted for further assembly

THE FINE DEGREE of synchronization needed along an assembly line is well illustrated by the Jefferson Avenue plant in Detroit, where Chrysler and De Soto Airstream and Airflow cars are assembled. A greater variety of models is built at this plant than anywhere else in the corporation, and therefore, the manufacturing problem is in many ways more complex than elsewhere.

Here is the problem for a single working day. The scheduling department has ordered production of 600 six-cylinder and eight-cylinder cars. They consist of four-door sedans, two-door sedans, rumble-seat coupes, business coupes, convertible sedans, convertible coupes, traveler sedans, seven-passenger sedans, an occasional town car or limousine, and perhaps a few chassis. The cars may be painted in any of ten standard colors or any special color the customer may specify.

There are 72 different engine combinations, depending on whether the car is for export or domestic use, whether it has an aluminum or cast iron cylinder head, whether it has an overdrive or standard transmission. Possible body combinations are legion. Standard models can be either de luxe or custom. Trim can be broadcloth, mohair or leather, plus any special orders. Rear axles, emergency brakes and propeller shafts can be for overdrive or standard transmissions. Wheels may be any one of ten colors; so may fenders, radiator shells, hoods and lamps. Any or all of these parts may be painted a special color.

One might enumerate various combinations almost indefinitely. It is enough to say that close to five million combinations are possible—all of which means that every car moving down the assembly line differs in some detail or equipment from the car in front of it and the car behind it. The job is to have the exact body, of the correct color, trim and model, over the chassis at a given point ready to be lowered on; and every other part of correct specification must be on hand at the right spot to be attached to the right car when it arrives there.

The problem is made more complex by the fact that there is no place for storage of the 759,000 parts handled each hour or of the 600 bodies required each day. The matter of routing material then becomes of major interest. Bodies, for example, are scheduled five days ahead, fenders and hoods 24 hours ahead.

Many parts entering into automobiles, of course, have their own assembly lines before they reach the final car assembly line—engines, rear axles, transmissions, steering gears, instrument panels, electric starting motors, brakes, etc. In many cases there are assembly lines ahead of these sub-assembly lines. Every instrument, such as the speedometer, oil gage and ammeter, must have its own assembly line before it reaches the instrument panel assembly, which in turn becomes a part of the body assembly.

All parts, materials and sub-assemblies, after having been designed by Chrysler and De Soto engineers and approved by the sales, manufacturing and cost departments, are purchased from Chrysler or outside plants. The cost price is arranged between the purchasing department and the vendor, whether the latter be a Chrysler plant or an outside company. The planning department is then responsible for getting in the parts and sub-assemblies to

Gray or green, sport roadster or four-door sedan, cars roll off in carload lots thanks to the "track sheet"

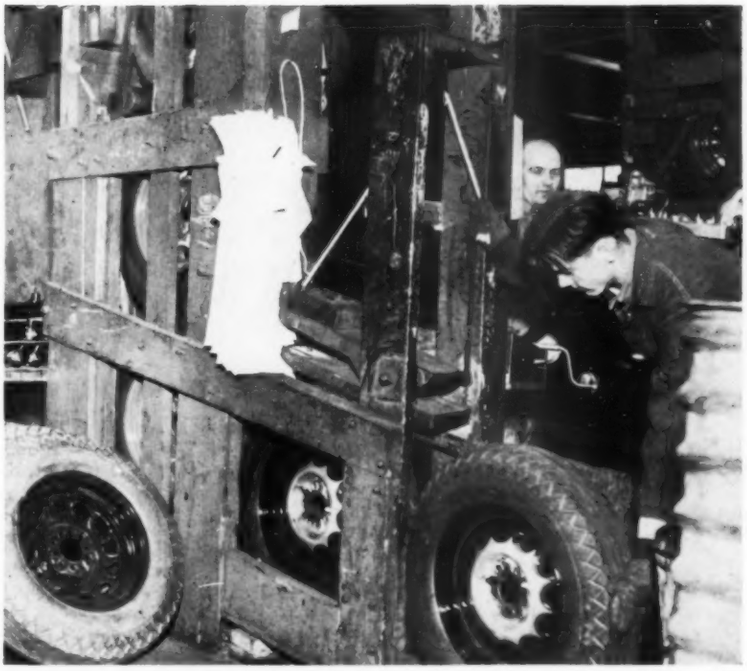
meet the assembly line schedule, doing this without holding an excessive inventory in stock.

The traffic department makes certain that the parts ordered by the planning department arrive on time. The plant engineer sees that the assembly line keeps running, that there is air and electricity for the various tools, that the equipment is in order, and that there is heat, light and water. The inspection department closely inspects all parts and materials and all assembled cars.

Every car to be built during a day is listed on a "track sheet." This sheet gives in code the specifications of every car from No. 1 to No. 600 (assuming that 600 is the day's total production) in the order of appearance along the line. Copies are sent to every department involved, so that all sub-assemblies reach the line with correct specifications at the right moment.

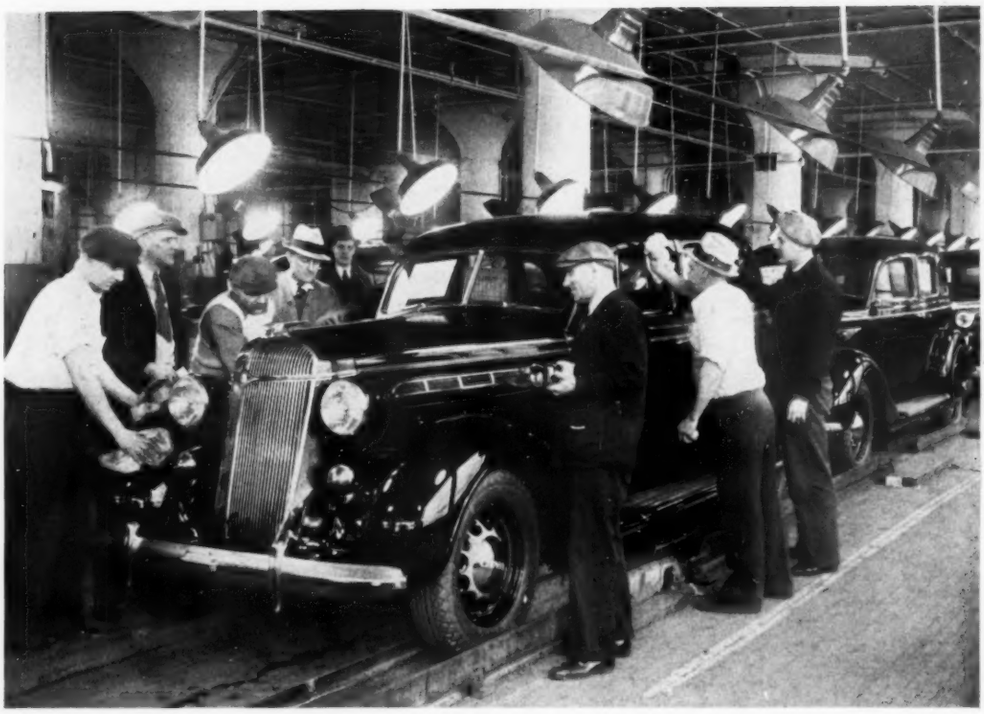
All the cars are built to order, track sheets being arranged so that cars are assembled in carload lots. In other words, a dealer may order (1) a gray convertible coupe with a red stripe, (2) a green two-door sedan with a yellow stripe, (3) a black four-door sedan with a green stripe and (4) a blue four-door sedan with a cream stripe. Cars come off the line in that order ready for shipment.

After cars are assembled, they are driven onto tuning rolls and subjected to a test similar to actual road performance. Rolls consist of a solid axle, at each end of which is a 26-in. cast iron wheel weighing one ton. The cars work against the force required to rotate the rolls against the friction of these weights. Rear wheels of the car contact the center of the periphery of the roll, while front wheels drop into



● **Discharged at the bottom of a chute, wheels of the proper specification are delivered to the line**

● **Circular assembly of the De Soto radiator shell is typical of hundreds of sub-assembly operations**



Embodying the painstaking efforts of thousands of individuals, a finished Chrysler car rolls off the final assembly line

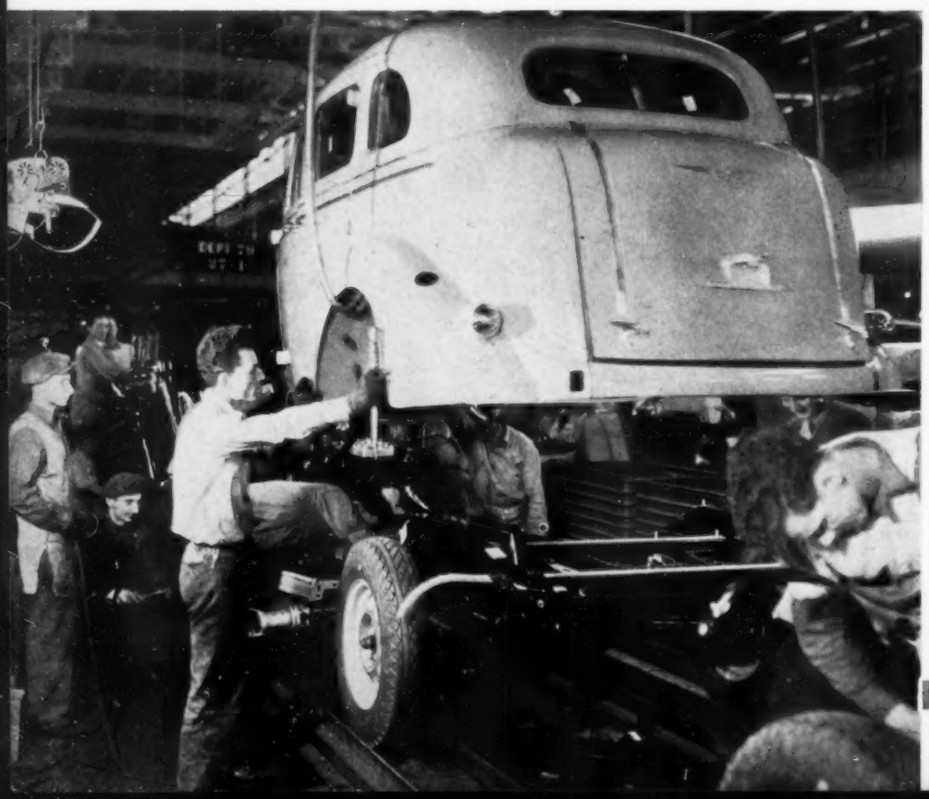
chocks to prevent the car from moving. The car then is operated at speeds up to 60 miles an hour, duplicating road performance in still air.

While cars are on the tuning rolls, they are carefully checked by the driver and his helper. These checks are for such matters as rear axle and transmission noise, engine noise, brakes, vibration, oil and water leaks, and smoothness of gears. Head lamps are accurately focused at this point.

Mechanical car parts are thoroughly tested before being sent to the assembly line. Engines have to pull their designated horsepower on dynamometers before being dropped into the chassis. Transmissions and rear axles are run in silent rooms under loads corresponding to those experienced in service. Generators, starters, distributors and ignition coils are separately tested before installation. Propeller shafts are properly balanced.

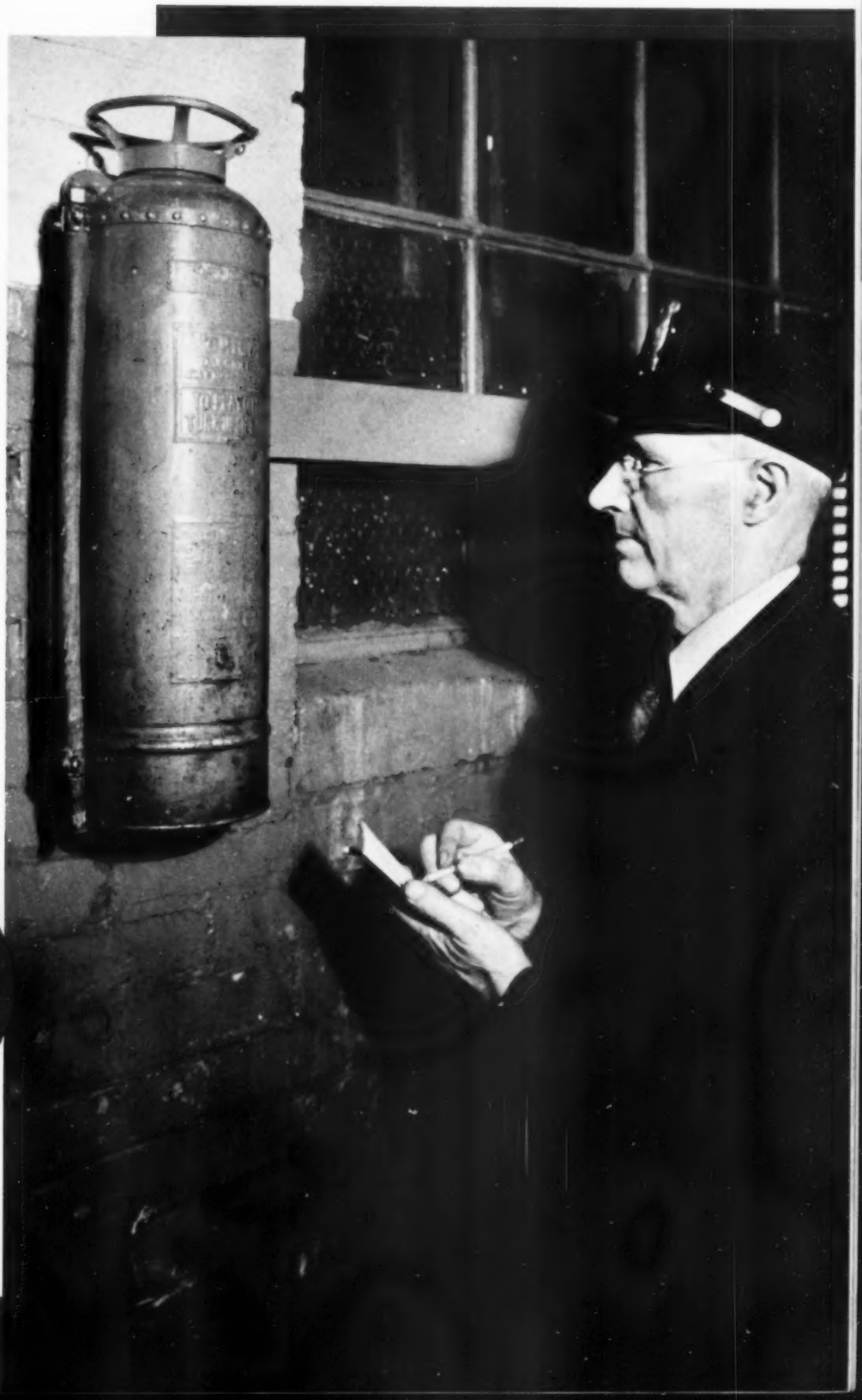
From tuning rolls the car proceeds to the final O.K. and factory new service line. Here the car goes through a series of fourteen operations, including a water test. With a man inside the car, it is sprayed at high pressure from all angles, the flow being equal to a torrential rain. There must be no leaks. All nuts and bolts are checked in pits and chassis oilers and grease cups filled. The car is cleaned, polished and touched up where necessary and anti-rust oil sprayed on all bright parts. After final rigid inspection, the car is driven away and turned over to the traffic department for either rail shipment or driveaway.

The chief inspector in charge of all car inspection is answerable only to the vice-president in charge of manufacturing. This puts him and his men in a neutral position uninfluenced by any affiliation with production departments and insures rigid impartial testing of all cars.



Carefully timed, bodies are lowered from the mezzanine to the chassis on the first floor

Plant Services



Tractors and trucks, trailers and dollies, for interplant transportation are controlled by dispatchers in a central office at the Dodge Truck plant

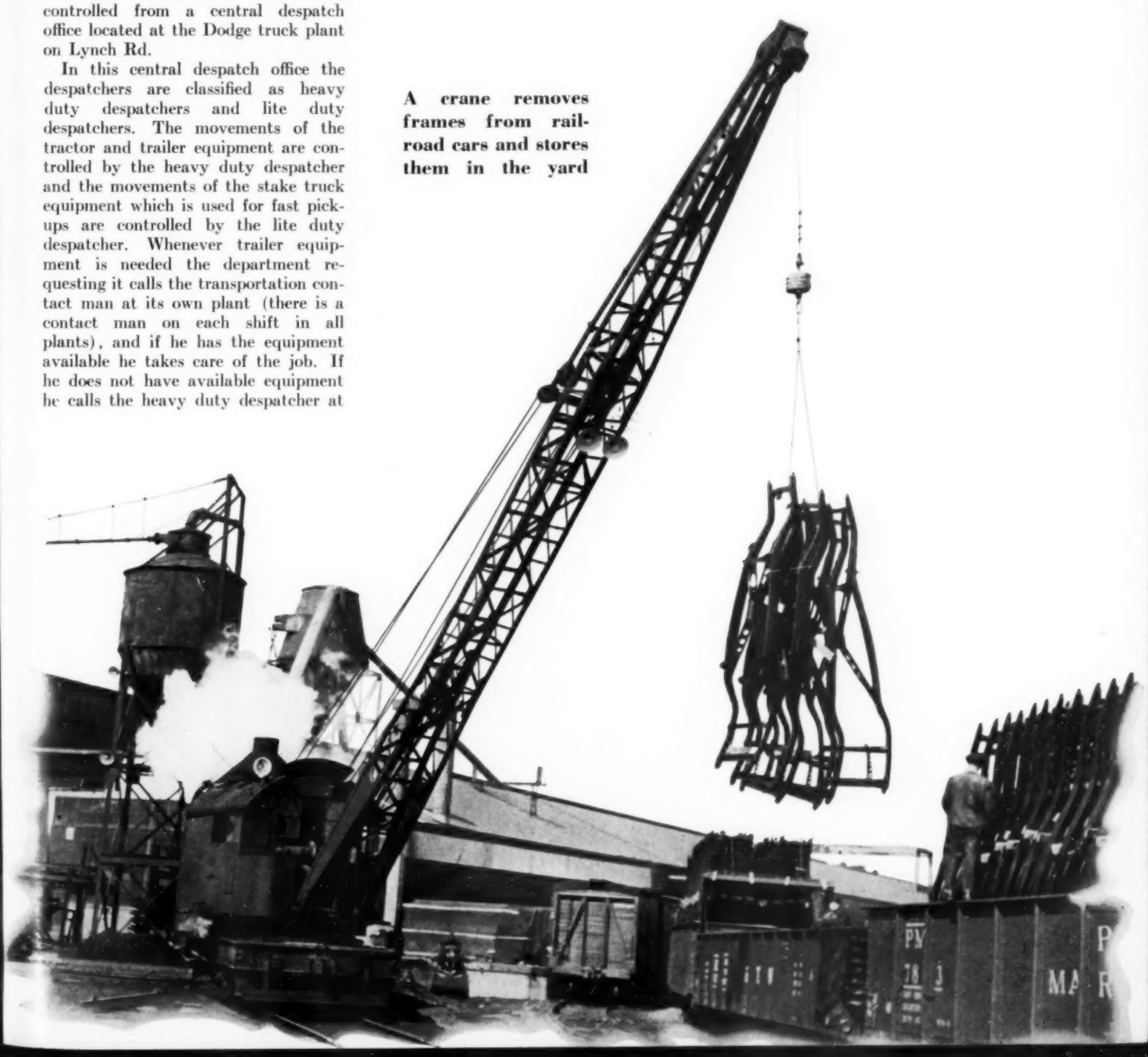
Off with another load — one of 315 units in interplant service

Every Day Is Moving Day

Interplant, intraplant and conveyorized transportation keeps the flow of parts in tune with the closely timed assemblies

THE SYSTEM for trucking materials and parts between Chrysler plants in and around Detroit resembles a miniature railroad. Main office and garage correspond to the round-house; trailers to freight cars; tractors to engines and stake trucks to fast trains. The department, in charge of a superintendent and assistant superintendent, handles an average of 4,000 to 5,000 tons each working day and in the last year transported about one million tons. Movement of 106 truck tractors and stake trucks, 187 trailers and 22 dollies is controlled from a central despatch office located at the Dodge truck plant on Lynch Rd.

In this central despatch office the despatchers are classified as heavy duty despatchers and lite duty despatchers. The movements of the tractor and trailer equipment are controlled by the heavy duty despatcher and the movements of the stake truck equipment which is used for fast pick-ups are controlled by the lite duty despatcher. Whenever trailer equipment is needed the department requesting it calls the transportation contact man at its own plant (there is a contact man on each shift in all plants), and if he has the equipment available he takes care of the job. If he does not have available equipment he calls the heavy duty despatcher at



A crane removes frames from railroad cars and stores them in the yard

the central despatch office and the despatcher sends the equipment in from one of the other plants.

It is also one of the contact man's duties to instruct a driver upon entering the plant where to take his load to be unloaded and instruct the driver as to his next move. As the contact man is in close touch with the plant's shipping and receiving departments he has been informed of what material inbound and outbound is rush so that he may get the rush inbound loads spotted for unloading and the rush outbound loads out of the plant first.

The central despatch office has a large board spaced vertically and horizontally. The horizonal spacing denotes the plants served by the equipment which are marked along the left hand side of the board. Above the vertical spacing is marked the equipment number. Each individual space is drilled so that a small peg can be inserted and a check vertically will show the equipment, and horizontally will show the plant where the equipment is located. When a driver checks out of a plant he calls the central despatch office and reports what load he has, where he is going and what truck trailer and dolly he has. The despatcher moves the peg on this board to show the particular movement and also makes a notation on the despatch sheet of the movement and the time for a permanent record. The running time between the plants has been studied and routes assigned and the despatcher can give out information as to the arrival of material at a plant to within a few minutes, and can also tell whether or not the driver is making his proper running time between the plants.

Each afternoon a list of drivers needed next day is posted at the garage, together with instructions regarding the time the men are to report and to what units they are assigned. Three shifts of mechanics are on duty daily at the garage for maintenance purposes. Daily and monthly records are kept of the cost of operating the department, covering such items as supervision, drivers, car operating expense and maintenance.

Each driver keeps a detailed account of his movements on a "Trip Sheet" which is turned in to the garage office at the end of each day. It lists each stop, time in and time out of a plant, numbers of the trailers dropped at a plant and picked up, and weight of the material received and of the material delivered. At the bottom of the sheet the driver may list any complaints regarding his truck, such as items which may need attention in the garage. If he has been delayed during the day, he is asked to explain why.

One of the very important factors in the operation of this equipment is accident prevention. To insure greater visibility to traffic on the streets all of inter-plant equipment has been painted a bright orange which makes it very distinguishable day or night. All tractor and trailer equipment is equipped with power brakes and the drivers have attended a traffic school under the direction of the police department. Safe driving certificates are issued to drivers every six months for the operation of a vehicle without an accident for that period. In case of an accident where the driver is at fault a penalty system is used.

Intraplant Transportation

RAPID and efficient trucking of parts and materials within a plant is of equal importance with conveyors in the attainment of economical production costs. The expense of moving stock from one place to another can easily mount to excessive heights unless close watch is kept on doing the job with a maximum of efficiency in a minimum of time. At the Dodge Division of Chrysler Corporation in Detroit a trucking system has been developed which is second to none in the industry. It does a big task so well that a description of it and how it functions appears in order.

An average of 115 carloads of freight are unloaded at the Dodge plant every working day, and the equivalent of 90 carloads is unloaded from trucks and trailers. As much as 2,500,000 lb. of sheet steel is unloaded in 24 hr., and in addition approximately 4,000,000 lb. of miscellaneous materials are received and shipped out of the plant in a single day, all of which must be handled by electric trucks. A tentative forecast of carloads, made three weeks in advance, controls the man-power requirements of the car-unloading and transportation departments. All carloads of material

Parts are trucked on skids or in tote-boxes from the receiving room to the point of usage

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INTERNAL TRUCKING

TRUCK DRIVERS' DAILY SERVICE REPORT

CHECK ITEMS REQUIRING ATTENTION

Truck No. 57 Date 2/19 193 6

Gang Boss Name E. Bentz

Driver's Name J. Wolf Badge No. 19-98 2

Time Started 330 Time Finished 11

	✓		✓
DRIVE UNIT		**CONTROLLER**	
Noisy		Sparks Badly	
Wheels Wabble		No First Speed	
Brakes Faulty		No Second Speed	
Tires Bad		No Third Speed	
Drive Flange Bolts Out		No Fourth Speed	
TRAILING UNIT		**POWER UNIT**	
Wheels Loose		No Power	
Bearing Cap Loose or Off		Motor Missing	
Tires Bad		Motor Runs Hot	
Needs Lubrication		Radiator Leaks	
PLATFORM		Motor Knocks	
Does Not Lift		Oil Gage Doesn't Work	
Does Not Stop at Top		**MISCELLANEOUS**	
Does Not Stop at Bottom		Horn	
Stops Too Slowly		Battery Cover Loose	
Broken		Frame Needs Repair	
STEERING		Needs General Lubrication	
Loose		Needs Wash and Clean	
Tight		**SUPPLIES**	
Steers Hard		Gasoline—Gallons	10
Needs Lubrication		Oil—Quarts	2
		TRUCK IS O. K.	OK

REMARKS:

INSPECTED AND O. K. BY

(OVER)

INSTRUCTIONS TO DRIVERS

THIS EQUIPMENT REPRESENTS A CONSIDERABLE INVESTMENT, TRY TO KEEP IT OPERATING EFFICIENTLY. THIS REPORT IS FOR YOUR BENEFIT AS WELL AS FOR THE EQUIPMENT.

THE FOLLOWING RULES TO BE FOLLOWED:

1—ALL DRIVERS are to make this report daily.

2—ALL DRIVERS are to use the same truck every day unless otherwise instructed by his foreman.

3—FOR SAFETY—Absolutely refuse to operate a truck or tractor with faulty controller, brakes or steering gear. You will be held responsible for accidents.

4—ANY ACCIDENT must be reported immediately to your foreman, whether it concerns your truck or other factory equipment. Drivers failing to do this will be severely penalized.

5—NEVER ALLOW a broken down truck to be pushed. Call repair department—automatic 'phone No. 552, for tow into garage if necessary.

6—LUBRICATION—(This is Very Important) See that your truck is properly greased and oiled at regular periods. Check this with the greasing chart in repair department provided for that purpose.

REMARKS:

are checked against the time study rating to insure materials being unloaded efficiently. The yardmaster at the Dodge plant makes out a daily check of freight cars in the three railroad freight yards, a copy of which goes to the inter-plant transportation department, so that the demurrage situation may be watched closely and cars unloaded in direct relationship to production requirements.

The handling of such a huge volume of freight necessitates operation of a well organized department, equipped with modern transportation facilities. This department has a fleet of 64 electric trucks, 31 gas-electric trucks, 19 mule-type electric tractors, and 3 gas-driven tractors.

The man-power in this department is divided into three groups, consisting of: 53 drivers in the manufacturing division, 31 drivers in the pressed steel division, and 45 drivers in the foundry division. These drivers are operating on three eight-hour shifts, and each driver is assigned to a given task, supervised by group leaders. The major portion of the material is moved in

An old battery is hoisted out of position in the truck and a fully charged battery inserted. Each truck has a standby battery

steel containers known as skid boxes, which are loaded at the receiving departments. The materials are retained in these containers until used in production or unloaded on conveyors for assembly, thus eliminating excessive handling and transfer costs. The Dodge plant alone has approximately 11,000 containers, 31 in. wide x 48 in. long x 25 in. high, which are constantly being rotated throughout the plant to accommodate the transfer of materials as they are being received or fabricated.

Dodge Plant officials have found that electric trucks in particular provide fast, efficient and economical means of transporting material. Special electric trucks have been developed for handling and piling sheet steel in places not equipped with over-head cranes. These trucks have a capacity for piling 4 tons of sheet onto a pile 5 ft. high.

Each night, all trucks are brought in to headquarters for inspection. They are also washed and greased in accordance with an operating chart, which is kept up to date and insures all trucks being properly maintained for efficient operation. This work is maintained by three shifts of mechanics, and a very accurate cost of operation is maintained on each piece of equipment. All electric-driven trucks are provided with dual battery equipment and the batteries are changed at the end of each shift in the minimum space of time.

Truck drivers are required to make a daily report of their equipment which needs attention. They are asked to check the operation of their trucks in detail. In this way there is no shifting of responsibility from employees working on one shift to those of another. The truck drivers are instructed that they are operating a piece of equipment representing a considerable investment, and that they must operate it efficiently. They are also warned that they are held responsible for accidents, and they should refuse to operate a truck or tractor with faulty controllers, brakes or steering gears. Drivers failing to notify their foremen regarding accidents are penalized.

Conveyors are Indispensable

IN THE MODERN automobile plant conveyors are a necessity. It has long been a well established fact that progressive assembly lowers costs. For handling material, particularly from one point to another through buildings where the floor space is being intensively used for manufacturing operations, conveyors not only reduce the cost because of the elimination of manual trucking, but also relieve congestion in the aisleways and reduce damage to manufactured parts, for the reason that the parts hung on the conveyor do not need to touch one another and are not subject to collision as when transported along the floor on a truck.

Every manufacturing plant within Chrysler Corporation is conveyorized. There is no more interesting sight in the industry than to step inside the Plymouth factory in Detroit and view the intricate web of overhead conveyors carrying parts through sub-assemblies and finally delivering them to the final assembly lines. Conveyors are extensively used at the Jefferson Avenue plant, where Chrysler and De Soto cars are built, at the Kercheval plant in connection with body production, at Highland Park and Newcastle plants in the manufacture of parts, and in assembly branches at Evansville, Ind., and Los Angeles, Cal., as well as in the Dodge Truck and Canadian plants.

Perhaps the most complex use of conveyors is in the mammoth Dodge factory in Detroit. Here a number of multi-story buildings have been adapted to modern automobile production processes, economical operation being accomplished largely because of the ingenuity shown in connecting one process with another by means of conveyors. Over 400 separate conveyors link together various departments and provide transportation for materials within departments.

The general flow of materials within the Dodge plant is as follows:

(1) received and conveyed to storage or sub-assembly; (2) conveyed through sub-assembly; (3) conveyed from storage or sub assembly to as-

Near the end of a Plymouth line

Table I—Analysis of Conveyors

Purpose of Conveyors	Number of Conveyors	Type of Conveyors	Total Work Length-feet
To deliver material from press room or receiving docks to parts finishing and body assembly, contacting storage en route	4	Overhead	12,980
	1	Wood slats on two chains	122
	1	Two chains with cross bars	350
To carry fenders, hoods, tonneaus, etc., through finish operations	5	Fixtures on single chain	760
	4	Wood slats, two chains	1,185
	1	Belt	100
	1	Fixtures on overhead	672
	1	Trucks pushed by chain	154
To deliver parts from finish to assembly or rust proofing	5	Overhead	5,540
For making sub-assemblies prior to the final assembly of the body-in-white	2	Fixtures between two chains	960
	2	Fixtures on trucks pushed in loop	392
	2	Metal slat on two chains	317
For transporting sub-assemblies to assembling points	3	Wood slats on two chains	185
	2	Overhead	720
To carry bodies through the final body assembly	4	Trucks pushed by chain	2,550
Returning body trucks	1	Overhead	1,830
To deliver stampings and assemblies to dock for shipment to other Chrysler plants.	2	Overhead	3,260
To carry bodies from the assembly department to the paint department and between floors in the paint department then returning trucks to the assembly department	1	Trucks pushed by chain	1,416
To carry bodies through the following operations: Clean, bonderite, prime, spray, prime coat bake, glaze surfacer, surfacer bake, water sanding, dry-off after sanding, spot spray, ground coat, putty, inspection, lacquer spray, lacquer bake, water sanding, polish, inspection, repair, lacquer touch-up, dry-off polish and repair	42	Trucks pushed by chain	14,694
	14	Trucks pulled by bars operated by air cylinders	3,850
Transfer bodies from ovens to next operation	3	Trucks pushed by chain	280
For making sub-assemblies prior to the body trimm	7	Belt	1,189
	3	Fixtures pushed in a loop	733
	2	Fixtures between two chains	218
To carry sub-assemblies between assembling points	3	Overhead	2,508
	2	Belt	150
To convey bodies through the top trimming, complete inside trimming, seat installing, hardware installing, polishing and striping, then delivering the bodies to where they are installed on the chassis, or shipped to another Chrysler plant	9	Trucks pushed by chain	5,374
To return the body trim trucks back to the starting point	1	Overhead	4,244

Body parts coming down by elevator

semblies of larger units or of final assemblies; (4) through the assemblies; and (5) shipped out of plant.

Conveyors are grouped in two classes for stock handling and assembly. Some types of conveyors can be used for either class. Stock-handling conveyors include all continuous power-driven units which deliver stock without work being performed on them while in transit. Wherever possible, these conveyors have replaced trucking.

Every piece handled is a separate problem. The solution is based on the nature of the part, the volume handled, the operations to be performed and the nature of the building. A part might be conveyed between floors, but trucked if an elevator were not involved. Overhead conveyors adapt themselves to most of the stock handling problems where trucking is not necessary. This type of conveyor has the advantage of curving vertically as well as horizontally, making it possible to go almost anywhere. The main exceptions are slat, belt or two-strand conveyors. Slat and belt conveyors are used where parts can be set or thrown on a moving surface. Belt conveyors have the advantage of not allowing small parts to fall through, and not damaging finished surfaces. It is necessary in a few cases to suspend parts from a cross bar between two chains.

Assembly conveyors carry materials

through assembly operations, whether manual or mechanical. The majority of these conveyors carry parts or assemblies in desired positions past operators. In many cases the part is held on a fixture or truck.

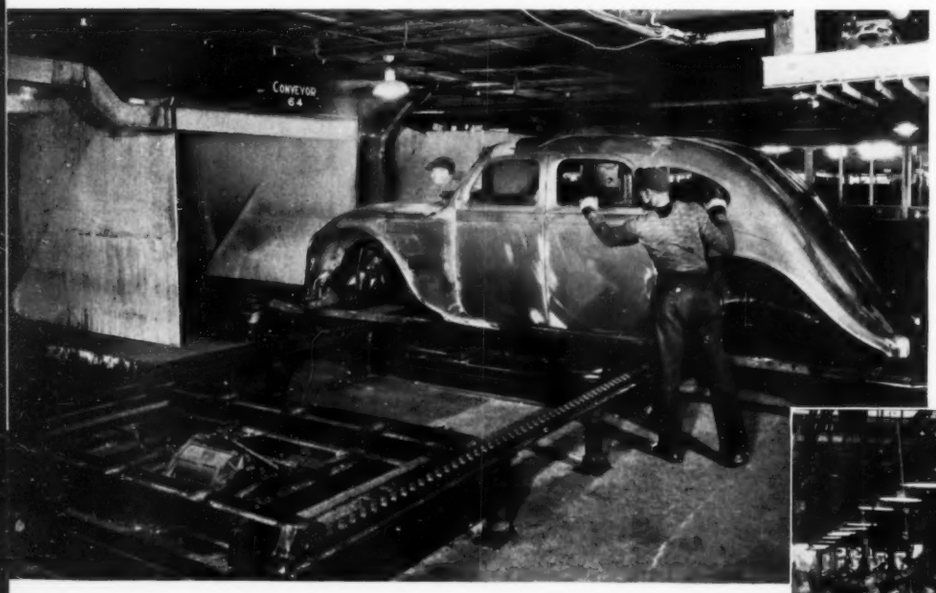
This carriage is pulled by one or two chains. In some cases the carriage completes the circuit, in others the truck is removed and loaded on another conveyor without detaching the part. There are so many types of conveyors used for assembly, each type having varied applications, that it is impossible to discuss all of them in a short article.

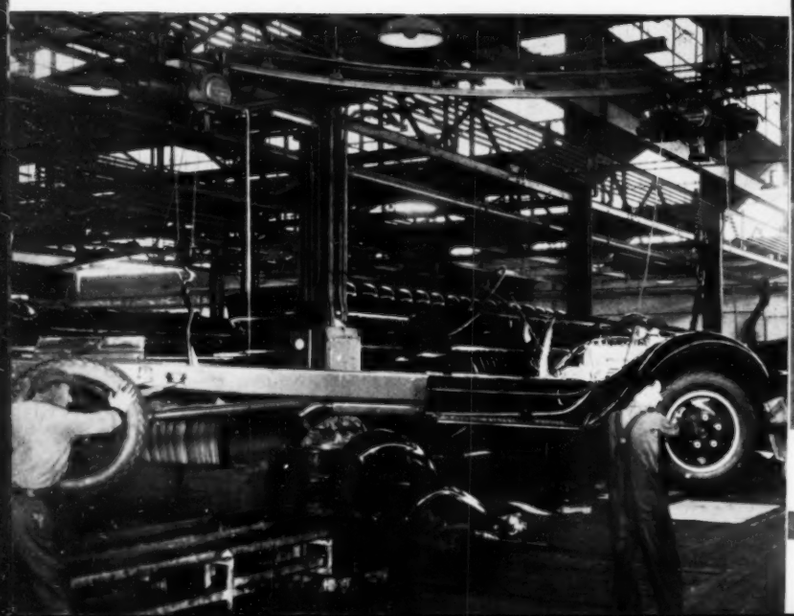
An elaborate example of conveyor usage is found in the eight-story body building, where stampings are made and received on the first floor, finished on the second floor, assembled on the eighth and seventh floors, painted on the sixth, fifth and fourth floors and trimmed on the third floor. This area is covered by a network of 128 separate conveyors with a total length of 12.6 miles. Table I breaks this down by use, showing the number, types and length.

Wherever practical, the Dodge Division has standardized on conveyor equipment. All contractors are asked to meet Dodge specifications and not install conveyors according to their own standards. This rule sometimes involves a small additional initial outlay, but the extra expense is more than offset by the lower cost of spare parts which must be carried in stock. This policy also prevents a contract from being awarded to the vendor who may intend to use the cheapest material.

Research work is carried on constantly to determine the best conveyor equipment suitable for specific purposes. Such work consists of the testing of equipment by the metallurgical department, just as car parts are tested, and of observing how equipment stands up in operation. Conveyors are completely overhauled once a year, the work being done when plants are shut down for change of models. At that time many alterations are made in existing conveyors and new equipment is installed. Such work is contracted, the Dodge conveyor maintenance men being left free to overhaul all conveying machinery.

Most car parts are produced in two shifts working five days a week. In addition to the conveyor maintenance men who are on duty during these shifts, there are men in the third shift and on Saturday to make necessary minor repairs.



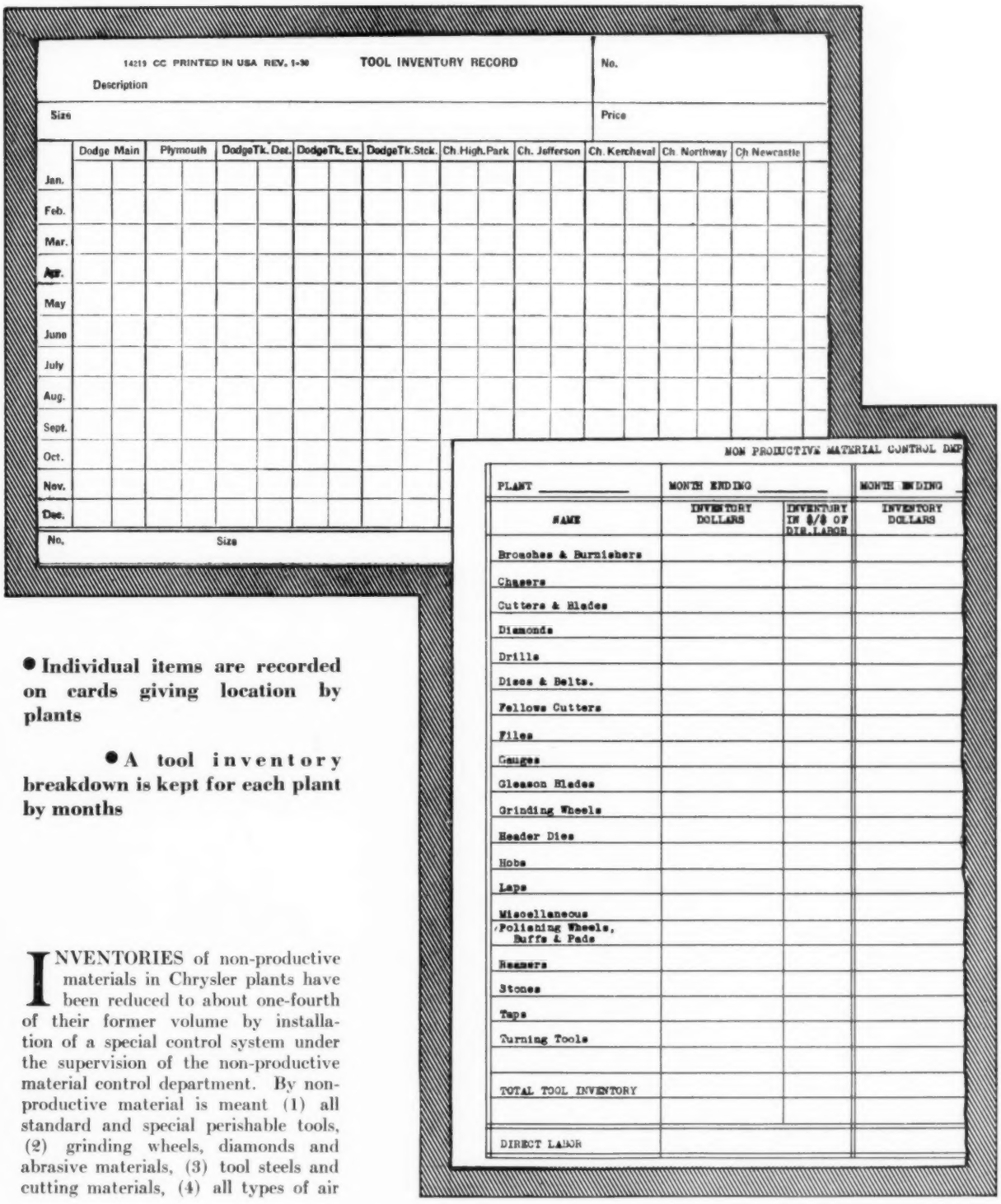


● ***Left*** **— A transfer table makes it easy to shift a body from one conveyor to another**

● ***Lower Left*****—Two monorail hoists handle a Dodge truck assembly**

● ***Below*** **— Plymouth radiators are assembled along a conveyor with padded slats**

A Central Control For Tools and Supplies



14219 CC PRINTED IN USA REV. 1-36 TOOL INVENTORY RECORD

Description | No.

Size | Price

	Dodge Main		Plymouth		DodgeTk. Det.		DodgeTk. Ev.		DodgeTk. Stck.		Ch. High. Park		Ch. Jefferson		Ch. Kercheval		Ch. Northway		Ch. Newcastle	
Jan.																				
Feb.																				
Mar.																				
Apr.																				
May																				
June																				
July																				
Aug.																				
Sept.																				
Oct.																				
Nov.																				
Dec.																				

No. Size

NON PRODUCTIVE MATERIAL CONTROL DEP

PLANT _____ MONTH ENDING _____ MONTH ENDING _

NAME	INVENTORY DOLLARS	INVENTORY IN $/$ OF DIR. LABOR	INVENTORY DOLLARS
Broaches & Burnishers			
Chasers			
Cutters & Blades			
Diamonds			
Drills			
Discs & Belts.			
Fellows Cutters			
Files			
Gauges			
Gleason Blades			
Grinding Wheels			
Header Dies			
Hobs			
Laps			
Miscellaneous			
Polishing Wheels, Buffs & Pads			
Reamers			
Stones			
Taps			
Turning Tools			
TOTAL TOOL INVENTORY			
DIRECT LABOR			

● Individual items are recorded on cards giving location by plants

● A tool inventory breakdown is kept for each plant by months

INVENTORIES of non-productive materials in Chrysler plants have been reduced to about one-fourth of their former volume by installation of a special control system under the supervision of the non-productive material control department. By non-productive material is meant (1) all standard and special perishable tools, (2) grinding wheels, diamonds and abrasive materials, (3) tool steels and cutting materials, (4) all types of air

CENTRAL TOOL CONTROL INVENTORY AS OF _____

PLANT _____

BR'T FORWARD

NUMBER	DESCRIPTION	SIZE	QUANTITY	PRICE PER UNIT	EXTENSION

Each month tool supervisors and planning supervisors in each plant receive a copy of the Central Tool Control Inventory

and electric tools, (5) maintenance materials, and (6) general supplies.

Functions of the non-productive material control department, which is a consolidation of the central tool control and standards departments under direction of the staff master mechanic, are numerous. One aim is to reduce inventories whenever possible by utilizing excess or obsolete stocks on hand in any plant to fill the requirements of any other plant. Another is to check purchase requisitions and vendors' shipping releases in order to determine if sufficient stock is available at any plant before further materials are bought and thereby prevent accumulation of excessive stocks. A third responsibility is to work with plant master mechanics to establish standards which will result in interchangeability of non-productive materials and small equipment among plants, thus giving the corporation larger purchasing volume, and to make all stocks suitable for use of different plants when required. Still another function is to determine where used or obsolete materials may be salvaged and employed economically.

The non-productive material control department keeps records of the physical inventories of items on hand in each plant. These items are listed on a form known as the "central tool control inventory," giving the number, description and size of the various items, but omitting the quantities. Copies of the list are furnished monthly to the tool supervisors and

Inventory Comparison

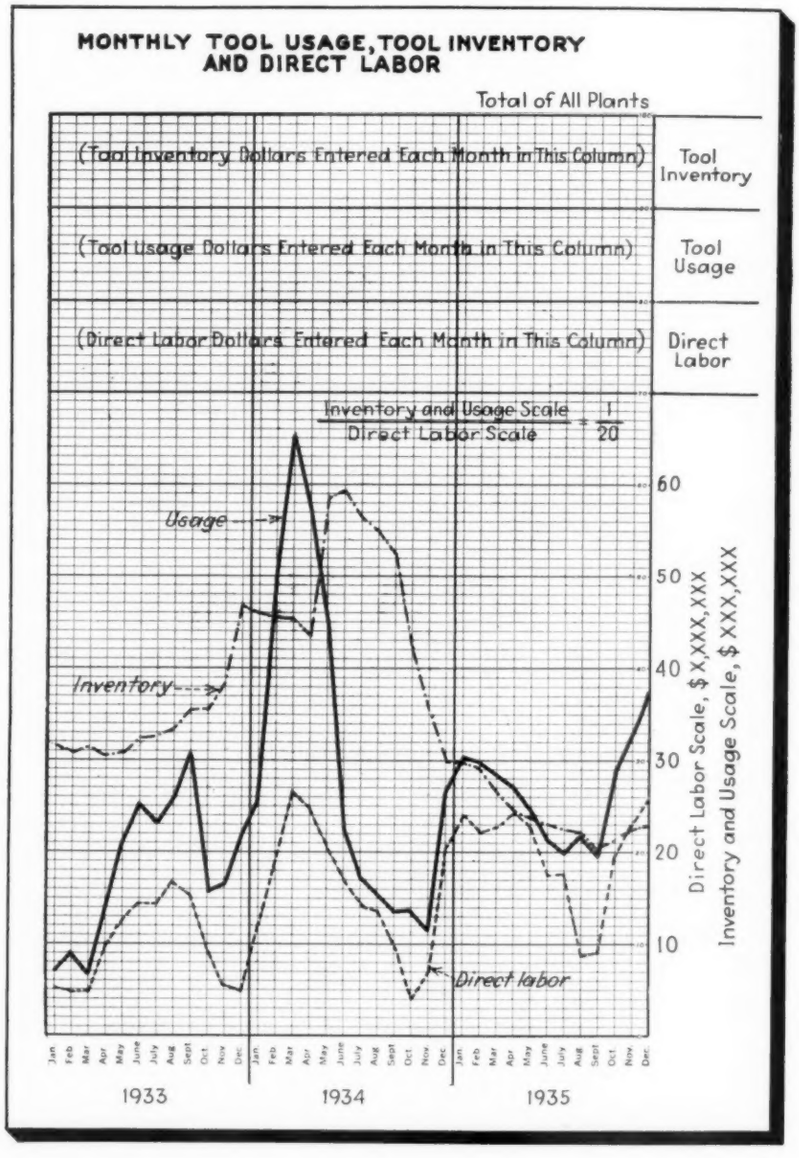
Each month the following figures are entered to show in dollars the relation between tool inventory and base inventory or average usage:—

For the current month:

- **Net over or under base inventory.**
- **Total amount under base inventory at certain plants.**
- **Total amount over base inventory at other plants.**
- **Total tool inventory.**

For the past year to date—average per month:

- **Possible saving — six per cent of average.**
- **Net over or under base inventory.**
- **Total amount under base inventory at certain plants.**
- **Total amount over base inventory at other plants.**
- **Total average inventory.**
- **Base inventory of average monthly usage.**



Typical of the control charts is that showing variations in tool inventory, tool usage and direct labor

planning superintendents of the individual plants, the list containing the materials handled by the particular department to which it is sent. The supervisors add the quantities of materials on hand and any new items of stock, returning the lists to the non-productive material control department, which enters these inventories on its records. These records show the monthly stock balances and indicate the usage of each item at each plant.

Whenever a plant needs any tools, equipment or materials of a non-productive character, it sends a purchase requisition or vendor's shipping release to the non-productive material control department which determines whether the materials can be supplied from the stocks available in any other Chrysler plant or whether they must be purchased. If purchases must be made, the department approves the original requisition and forwards it, with two copies, to the purchasing department. The fourth copy remains in the department's files. If the materials must be ordered against a blanket purchase order, the department approves and returns the vendor's release to the proper planning department or tool supervisor.

In cases where materials requisitioned are covered by standard specifications for non-productive materials, the standards number is put on the requisition or release by the issuing plant; this number in turn is carried over onto purchase orders and receiving reports. The non-productive material control department then checks the requisitions to make sure that materials ordered conform to the standards. It also scrutinizes requisitions for materials not covered by standards to determine the necessity for adding to the standards.

If the required materials are on hand in any plant, the non-productive material control department decides whether there is any surplus stock which can be released. If so, the department issues an interplant shipping release.

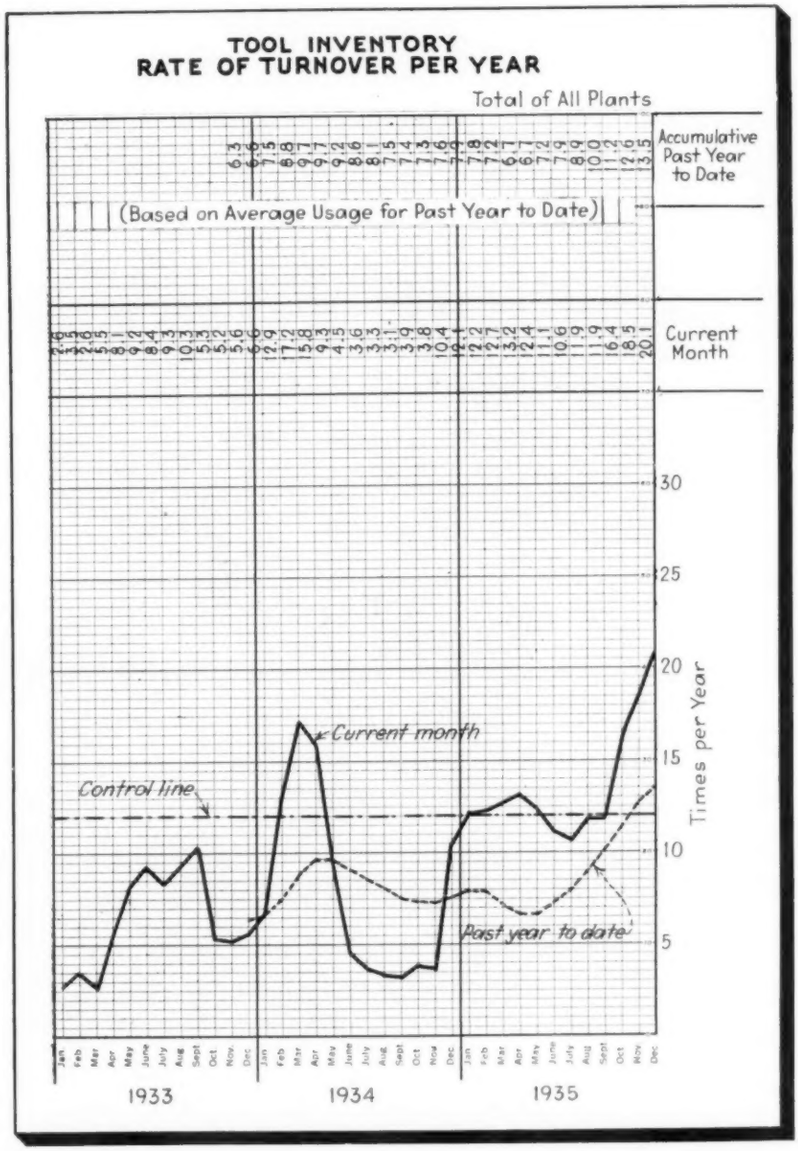
Central Stores

A central obsolete tool stores department is maintained at the Dodge main plant under supervision of the non-productive material control department. In this department are placed all obsolete or used tools which may be salvaged. When the tools are shipped in, no charge is made in favor of the department from which they came. They are obtainable by any other department from "obsolete stores" without charge except when salvage work has been done on them.

When special tools are obsoleted and provision has been made for service requirements, the plant tool supervisor in each plant submits lists to the non-productive material control department showing quantities and giving descriptions of the tools to be disposed of. The department indicates what tools are to be sent to the central obsolete tool stores department and which are to be scrapped.

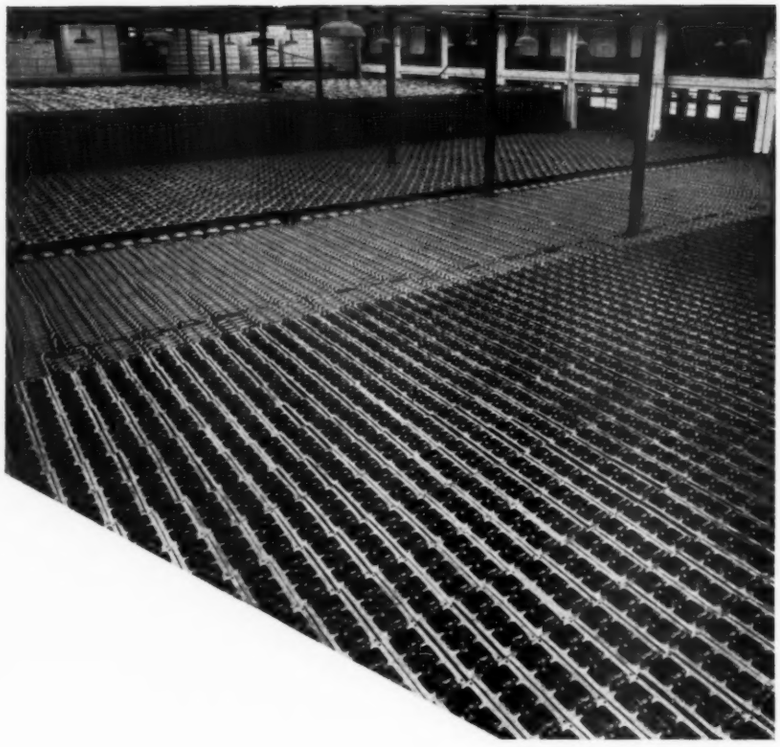
All obsolete new standard tools are sent to the central obsolete stores department, the non-productive material control department deciding which tools will be retained for possible use. Tools not salvageable are turned over to the by-products department for sale or scrapping.

The non-productive material control department decides when obsolete or used tools can be salvaged economically to fill current needs and by whom the salvage work should be done. This does not include salvage work which a plant may do on tools for its own use. Expense of salvage is billed to the plant using the tools. All obsolete standard tools shipped to Chrysler plants are stenciled with suitable identification marks to show that they are salvaged tools received at "no charge."



Another chart gives the tool inventory turnover rate, based on the average usage for the past twelve months

Row upon row of parts await the call of the production department

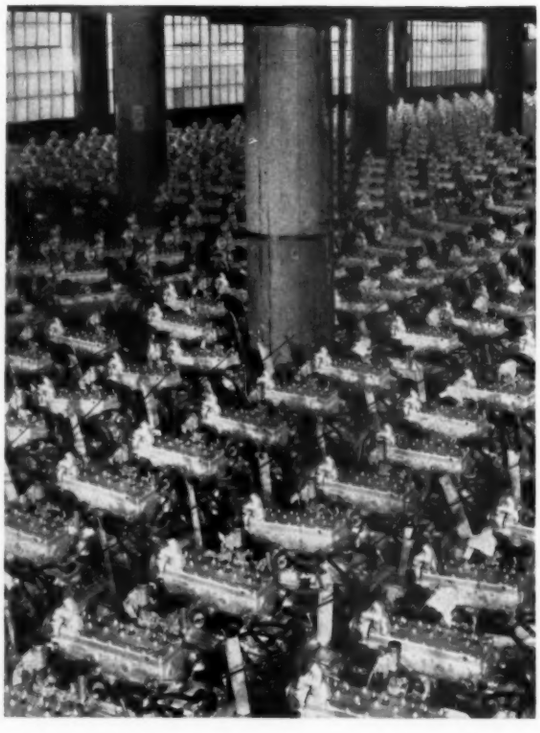


Production Planned

IT OFTEN IS a mystery to the average person how the automobile dealer down the street knows what new passenger cars to have in stock. If you walk into his establishment, you may find a blue four-door sedan, a black business coupe, a green two-door sedan and a snappy looking cream-colored convertible coupe. Duplicate that by many thousands of dealers, and you will get a representative idea of what one car manufacturer has in the field for immediate sale.

At first glance it may appear that production of these cars has been guesswork, but obviously a company cannot guess on a vast scale. It must have a fairly good conception of what the public wants, and anticipation of public desires in motor cars is traditional with Chrysler Corporation. It cannot build cars in large volume without a definite relationship to retail sales demand, yet at the same time it must manufacture and have in the field enough cars in sufficient variety to attract the customer to its products instead of to those of competitors.

The problem goes back still farther. The manufacturer must not only assemble cars in the right combinations of colors and of equipment and of models, but must also schedule the fabrication of parts so that every possible economy can be attained in costs and so that regular employees can be given as steady work as possible. There are more than 15,000 parts in an automobile. In a company which produces cars in large quantities, the number of individual items handled in a year amounts into the billions. Thus the correct gaging of materials and parts requirements becomes a matter of first-rate importance.

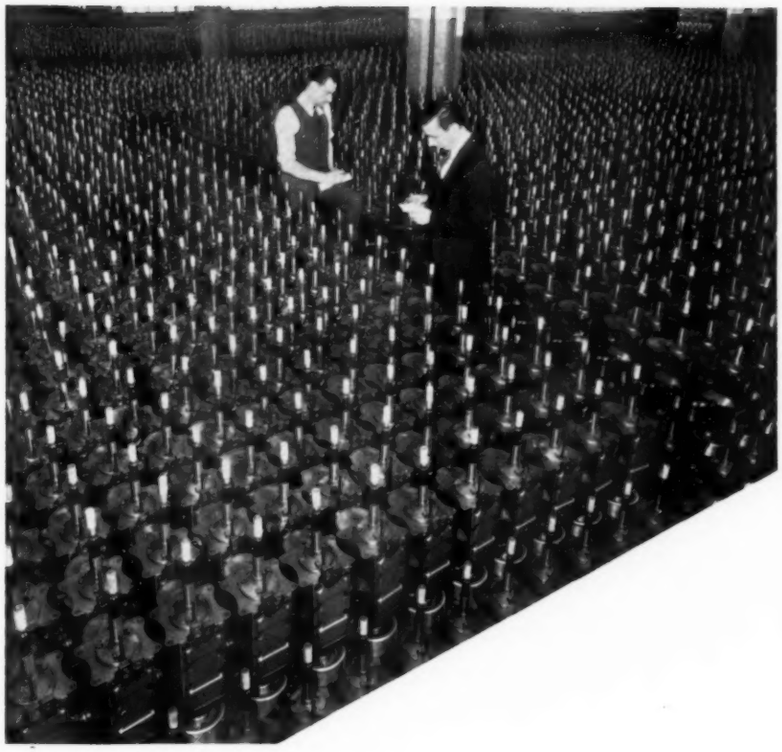


Chrysler Corporation has a definite program for meeting these problems. It starts back three months before cars are shipped from the factory. At that time the sales departments of each car division estimate how many cars they are going to need and how many cars must be built 90 days hence. These estimates are revised twice each month or oftener until the date of production is at hand.

When the final estimates are in, the general production department, consulting with the management, sets up a manufacturing schedule based on the number of cars necessary to maintain the estimated sales volume daily without making commitments for parts and materials which later might prove excessive.

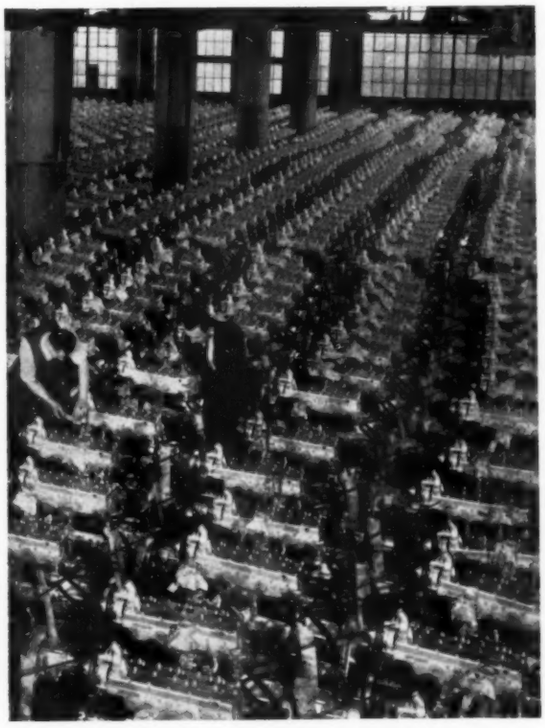
The general production department is charged with the responsibility for seeing that the proper balance is maintained between inventories and car production and retail car sales. It is the "watch-dog." It is inclined to be cautious in its authorizations, but seldom misses the mark very far.

Detailed release schedules of the number of units to be made are passed from the general production department



Not a field of daisies but transmissions by the ton, useful in smoothing out the employment curve

to Anticipate Sales



to the planning departments and operating managers of the individual plants. These schedules are the basis on which automobile parts are released for manufacture within the plant or for delivery by vendors.

No attempt is made by the corporation's management to dictate to each operating manager how parts or sub-assemblies are to be fabricated from day to day. It is his job to control his own inventory and to regulate production so as to achieve the greatest economies in keeping with efficient shop practice and with quality of workmanship.

Sales departments of the car divisions give shipping instructions regarding models, colors, etc., to the production departments seven days in advance. This policy eliminates any guesswork regarding the kind of cars to be built.

Production in each car division is controlled daily by the planning department in that plant. This department contacts the sales departments for car orders, releases materials requisitions to vendors, schedules the manufacture of parts through the shop, and receives materials, stores them and gets them to the production lines.

For years it was the custom to think about buying a new car in the spring—a tradition handed down from the days when motoring was a sport. So that production and employment might be distributed more evenly throughout the year, Chrysler Corporation in cooperation with the industry has been attempting to create a public demand during the time of year which traditionally was a poor selling time.

In conformity with this program, the Chrysler car divisions introduced their 1936 models in the fall of 1935 instead of waiting until January. The result was an encouraging sales response on the part of the public. This buying movement in the early winter, coupled with the necessity for stocking dealers adequately in anticipation of spring trade, kept the factories far busier than usual from October 1.

Further stimulus to steady factory operations has come from the policy of the corporation in manufacturing component parts and sub-assemblies in advance and storing them against future finished car requirements. In fact, Chrysler is not a recent recruit to the ranks of companies committed to this policy. Back in 1932 it started to level out production in this manner and thus maintain a steady working force.

Parts are fabricated and sub-assemblies produced considerably ahead of final assembly needs and are stored. These stocks then are absorbed during peak periods, cutting down some of the rush then, thus making it possible to employ a maximum force of steady workers for most of the year.

Safety guards, stock cribs, metal partitions, spray booths and a great variety of other sheet-metal work is made and repaired in a well equipped department

Maintenance: A Major Job

ADEQUATE PROVISION for maintenance of plant equipment and for machine repairs has been made in all divisions of Chrysler Corporation.

Many departments are partially or wholly concerned with maintenance work. One group takes care of all repairs and maintenance items on cranes in addition to operating them, and in plants where there are elevators this same group also runs and maintains elevators. The carpenter shop is a busy place, having charge of maintaining all wood floors, shop trucks, trays and benches. It builds partitions for changes in layout around the plant, and also special racks and bins. It constructs jigs and fixtures used in the manufacture of certain car parts, such as cushions.

The sheet-metal department has a variety of tasks. It fabricates steel racks and bins, installs safety guards for machinery and for power drives, and repairs and replaces washing machines, sand-blast equipment and sand-handling machinery. It makes metal trays to carry materials and installs ventilating systems. In the blacksmith shop forgings required for the toolroom and die shop, plus miscellaneous items like conveyor hooks, are produced and kept in repair.

Three key departments in connection with plant maintenance are the electrical department, millwright department and pipe shop. The millwright department is responsible for installing machinery and conveyors of all kinds, as well as countershafts and line shafts. Motors, generators, welding equipment and electric distribution lines are put in and maintained by the electrical department. The pipe shop installs all piping systems to connect various classes of equipment and maintains and repairs them.

Maintenance men are permanently stationed around the plant in manufacturing departments to keep shafts oiled and equipment in proper working condition. A crew of electricians is on hand, for example, wherever welding machinery is located so as to keep it operating efficiently. At the headquarters of key maintenance departments are crews subject to telephone calls from all parts of the plant. Calls are recorded on a trouble sheet, the repairman on each job marking the time he started out and the time he returned. If calls continue from one source over an extended period, a highly skilled man is dispatched to see what is inherently wrong with the equipment and correct it.

The electrical and mill wright departments have their own machine shops and the pipe shop is equipped with pipe threading machinery. The electrical department's shop is devoted to repairing motors, high cycle tools and other electrical tools and equipment. Each department doing maintenance work has its own foreman who reports to the superintendent of the maintenance division.

Machine repairs are handled by the machine repair department, which has men scattered over the plant to take care immediately of any breakdowns of equipment. In some departments, such as pressed steel and gear manufacturing, the men are on three shifts daily. In smaller departments from one to five men usually are on the job. There are special men to repair pumps, others on chains and hoists, on air tools and welding equipment, and on scales. A special gang is assigned the task of maintaining paint spray gun equipment.

Repair work, mostly of a nature which must be done quickly and cannot be sent outside, is done in the machine shop. The machine repair department usually includes a rebuilding gang which tears down machinery taken from production departments and completely rebuilds it for new jobs. Spare machine parts, numbered in the thousands, are kept in stock for replacement purposes. The repair cost of each productive machine tool is constantly under scrutiny; if the cost becomes excessive, it is retired.

Employment in maintenance and machine repair departments is remarkably steady throughout the year. Greatest activity is during the annual tooling period for new car models. Most of the extra help at such times is recruited from the ranks of the company's production workers who temporarily are not needed in their regular jobs.

The Plant Engineer's Part

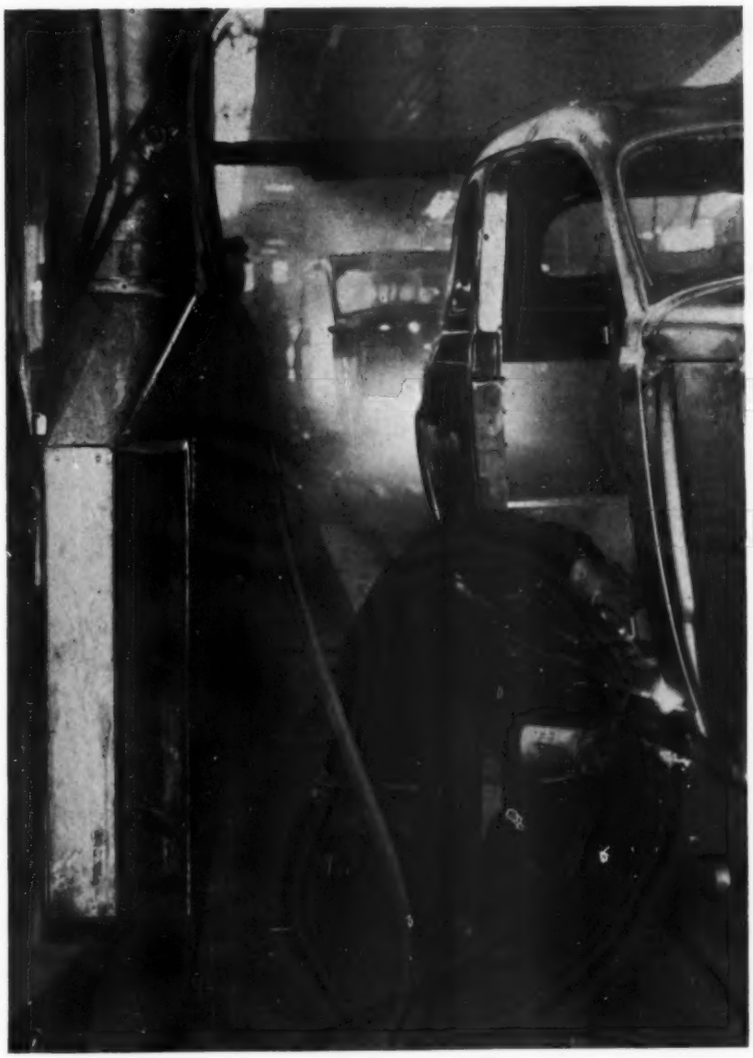
Production depends on an uninterrupted supply of light, heat, power and other vital services

ACTIVITIES classified as plant services are of far-reaching importance in the efficient operation of a manufacturing plant. One usually thinks of machine tools, stamping presses, welding machinery, paint spraying and other productive tools in connection with an automobile factory, sometimes forgetting the auxiliary equipment. Yet such matters as adequate lighting, heating and ventilating, removal of dirt, dust and fumes, and fire and police protection have a direct bearing on the safety and health of workers and in turn on the quality of the work they do.

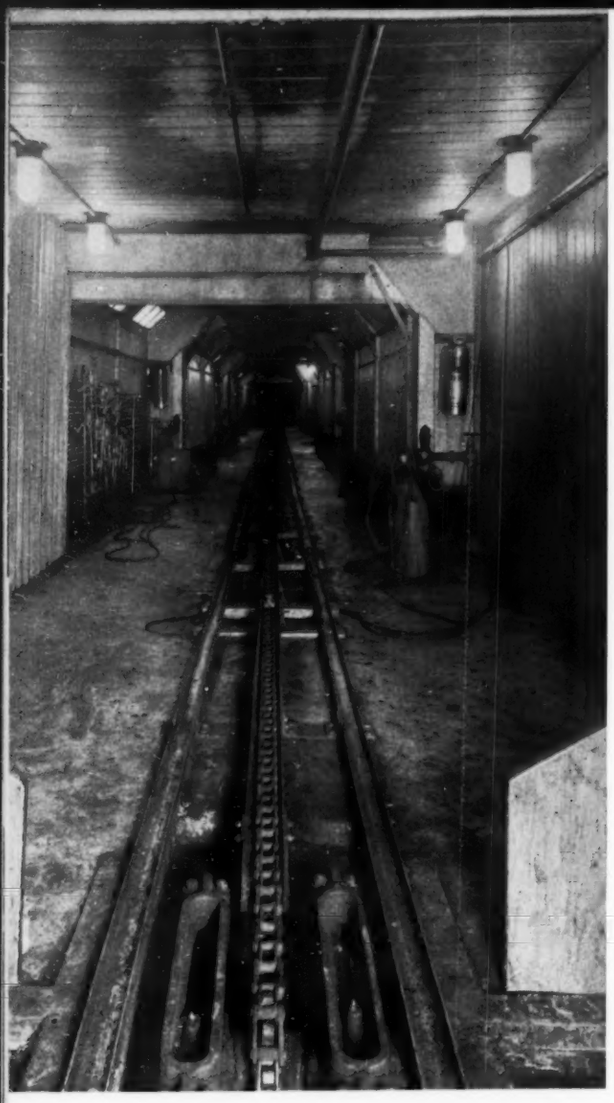
Look at the plant service problem, if you please, from the standpoint of the plant engineer. He has to see that each plant has the kind of heat, light and ventilation which its particular design requires, that electric power and compressed air are available at the desired points throughout the factory, that each department is protected to the greatest extent possible against fire.

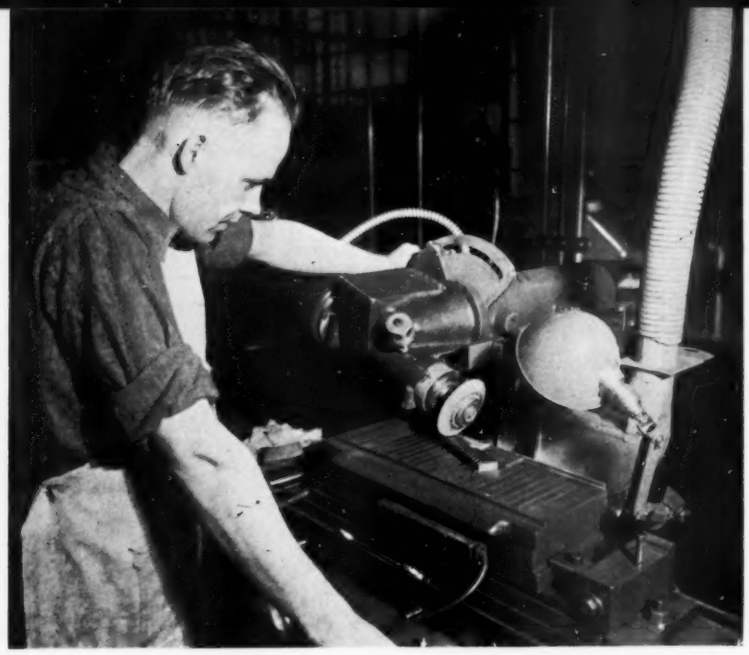
Floors must be of the right material. He must know how much space is needed for motor trucks carrying materials to get in and out of buildings and just how much head clearance must be allowed. He must be able to set up auxiliary equipment so that entire departments, including machinery, can be moved quickly to a new location. These are only a few of his many considerations from week to week.

Chrysler Corporation has been conscious of the essential rôle of plant services in its business. Everything is done to make working conditions comfortable and healthy. To cite only one example—elaborate equipment has been installed in the foundry to remove dirt, dust and fumes at a considerable cost to the management. Good lighting has



Fresh air, taken in from the roof, is distributed by ducts along the body line





● The job's the thing, but it could not be done without power and light delivered to the proper point

● In the hydrofilter spray booths a combination of mercury-vapor tubes and mazda lamps simulates daylight

been provided in all departments. Special care has been given to lighting properly spots difficult to reach.

Mercury vapor lamps are widely used throughout the corporation. In the body plant, for instance, a battery of 54-inch tubes of mercury vapor lamps parallels the line. In hydrofilter paint spray booths a combination of vapor tubes and mazda lamps is employed. This closely approximates natural daylight and there is no discomfort to operators from excessive heat.

The unit heating system is installed in many Chrysler plants. It has the advantage of being flexible so that heat can be concentrated in the part of the factory where it is needed and in case of retooling for a new car, the individual unit heaters can be moved about as desired.

The huge Plymouth factory is heated by a hot water forced circulation system, the water being heated by the exhaust from the steam hammers at the Dodge forge plant nearby. To pipe heat for such an enormous plant the supply and return hot water lines are each 22 in. in diameter and are placed in a tunnel connecting the two plants.

At the Dodge body plant, an indirect heating system is used, the system also providing ventilation during the summer months. Fresh air is drawn in on the roof of the building and distributed through ducts. On the seventh floor air is taken in by fans and carried by ducts along the body finishing lines. Similar equipment distributes air in the department where motors are given a block test after assembly.

Chrysler operates a plant protection department with a personnel of 404 men. This department's primary duty is to provide for the safety of employees and secondarily to protect the company's property. Each of the eleven fire marshals is an inspector whose job is to inspect all plant equipment constantly, particularly that classed as hazardous.

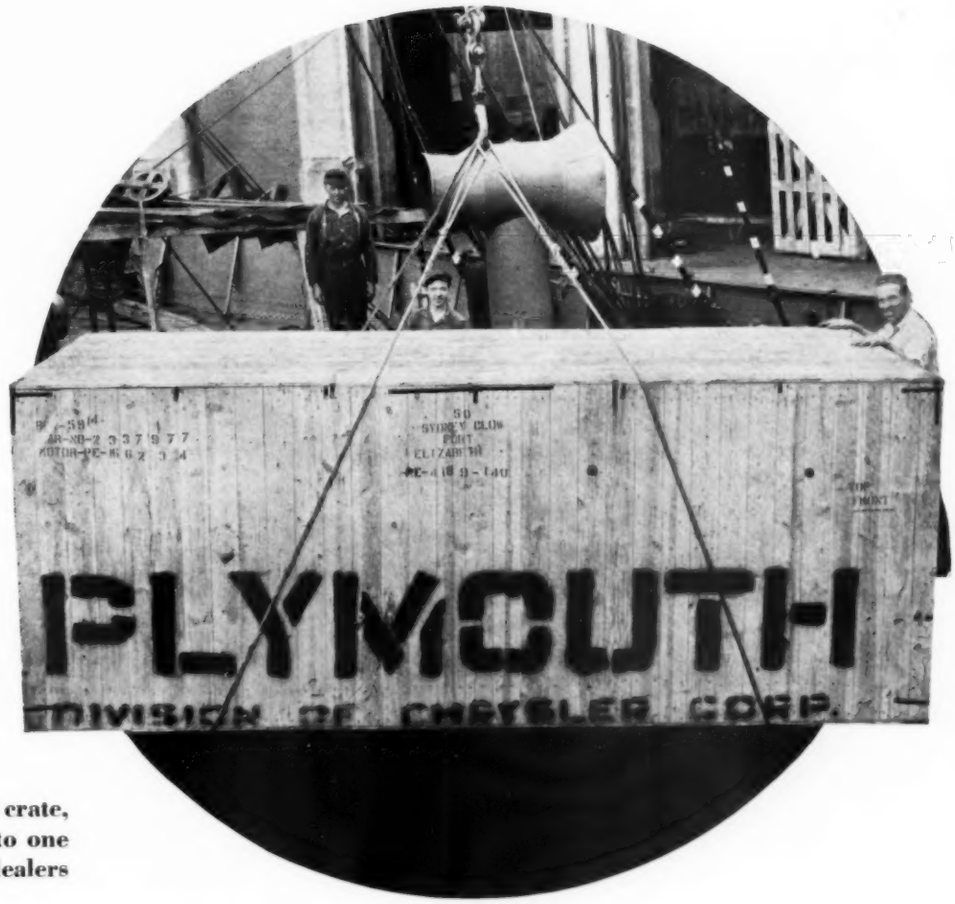
From October to June of each year a school of instruction is held in all plants to educate the men in their responsibilities. Conducted for an hour each week, these classes are instructed by men in the departments other than the chiefs. The rank and file participate in the discussions, often being assigned topics in advance to be worked out and presented at the next session.

Most of the corporation's buildings are equipped with automatic sprinkler protection against fire. Sprinkler lines usually are located under ceilings and have fusible link sprinkler heads about 10 ft. apart. Sprinkler lines inside buildings are constantly under water pressure. All paint spray booths have automatic sprinklers, spray booth stacks being equipped with open-head sprinklers. Such equipment as cyclone dust collectors and ducts connected to buffing, polishing and wood-working operations are provided with open-head sprinklers.

Portable Extinguishers

In addition to the automatic fire sprinkler system, portable fire extinguishers are located at convenient points around the plants. On walls and columns are 2½-gallon soda-acid extinguishers for fighting ordinary fires. They are supplemented by 40-gallon soda-acid engines mounted on wheels and equipped with 50 ft. of hose and shut-off nozzles. Foamite 2½-gallon and 5-gallon extinguishers and 40-gallon Foamite portable engines are available at suitable locations for use where a blanketing and smothering effect is necessary to stop fires in highly inflammable material. Carbon tetrachloride extinguishers have been installed to combat any electrical fires.

Compact Crating for Overseas

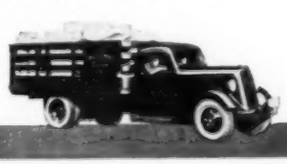


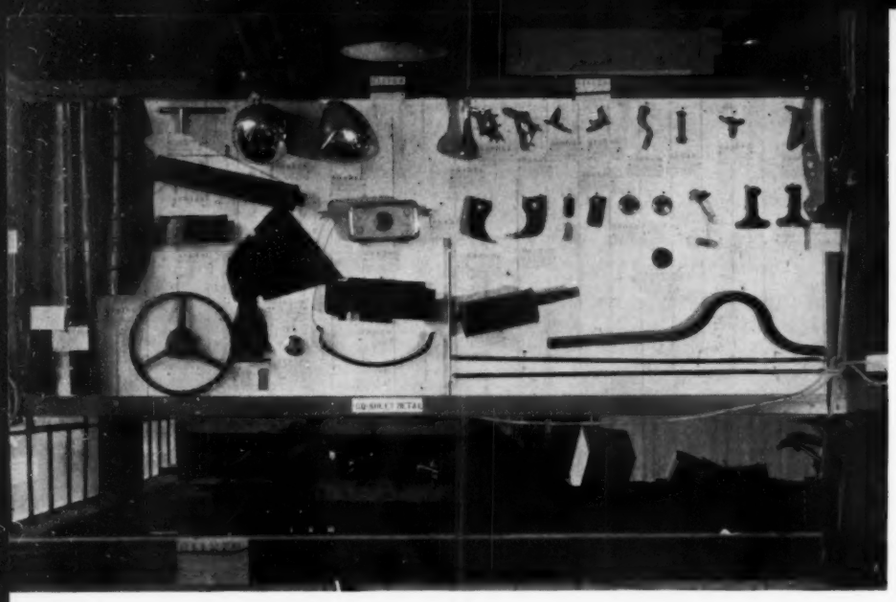
Into the hold goes the crate, carrying a Plymouth to one of Chrysler's 7,000 dealers abroad

CHRYSLER'S activities are by no means confined to the United States, but reach into all corners of the world through the export division of the corporation. Last year this division shipped overseas 75,000 cars and trucks, a total considerably larger than the domestic production of many companies.

In some countries independent native-owned companies assemble and sell Chrysler-built cars to dealers, these cars having been shipped "knocked down" from Detroit. In London, England, for instance, is Chrysler Motors, Ltd., employing 668 people and manufacturing and distributing cars throughout the British Isles. At Antwerp is the Societe Anonyme Chrysler with 175 employees. There are some 7,000 distributors and dealers abroad who have investments in Chrysler franchises amounting to $150,000,000.

Chrysler products are distributed and sold in 109 countries. The Export Division, with headquarters at Detroit, has 1,010 employees at home and traveling in the field. It produces cars which might aptly be termed "tailor-made." That is, they are built according to the requirements of vastly vary-





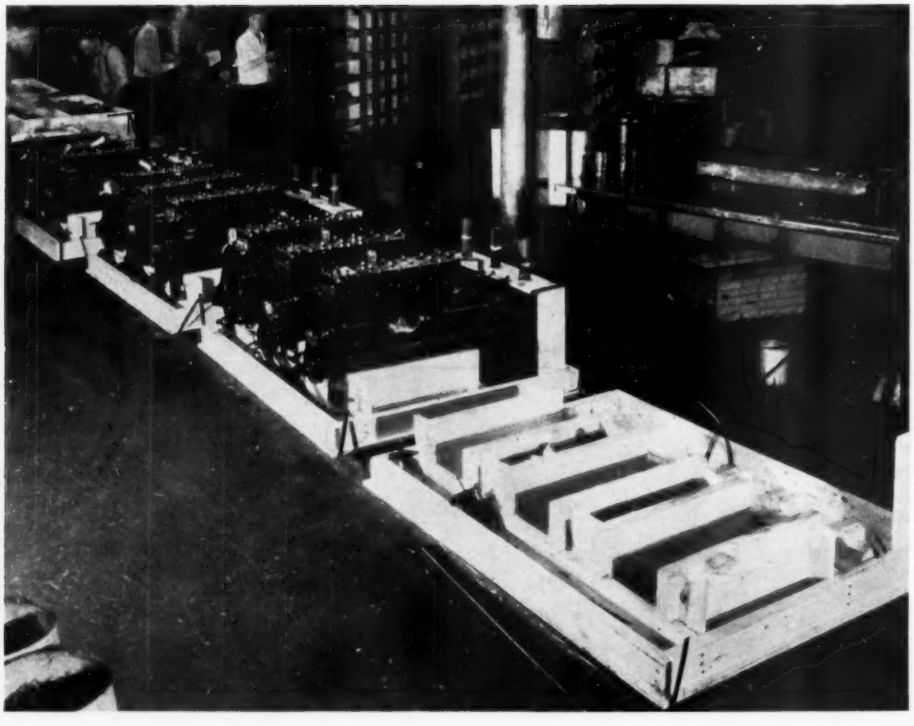
Master boards of sheet metal and body parts guide packers in preparing parts for overseas shipment

ing local conditions, frequently going through 18 to 30 extra operations. In one country, to cite examples, cars must be watertight, because in a year nearly 6 ft. of rain falls. In another country a carburetor which functions equally well at sea level and at an elevation of 6,000 ft. is essential. In many places dust seepage is a source of great annoyance and discomfort unless car bodies are air-tight.

Every car manufactured by Chrysler for overseas sale has a special large oil bath air cleaner, triple-sealed engine ventilation, extra strength thrust bearings and steering gears.

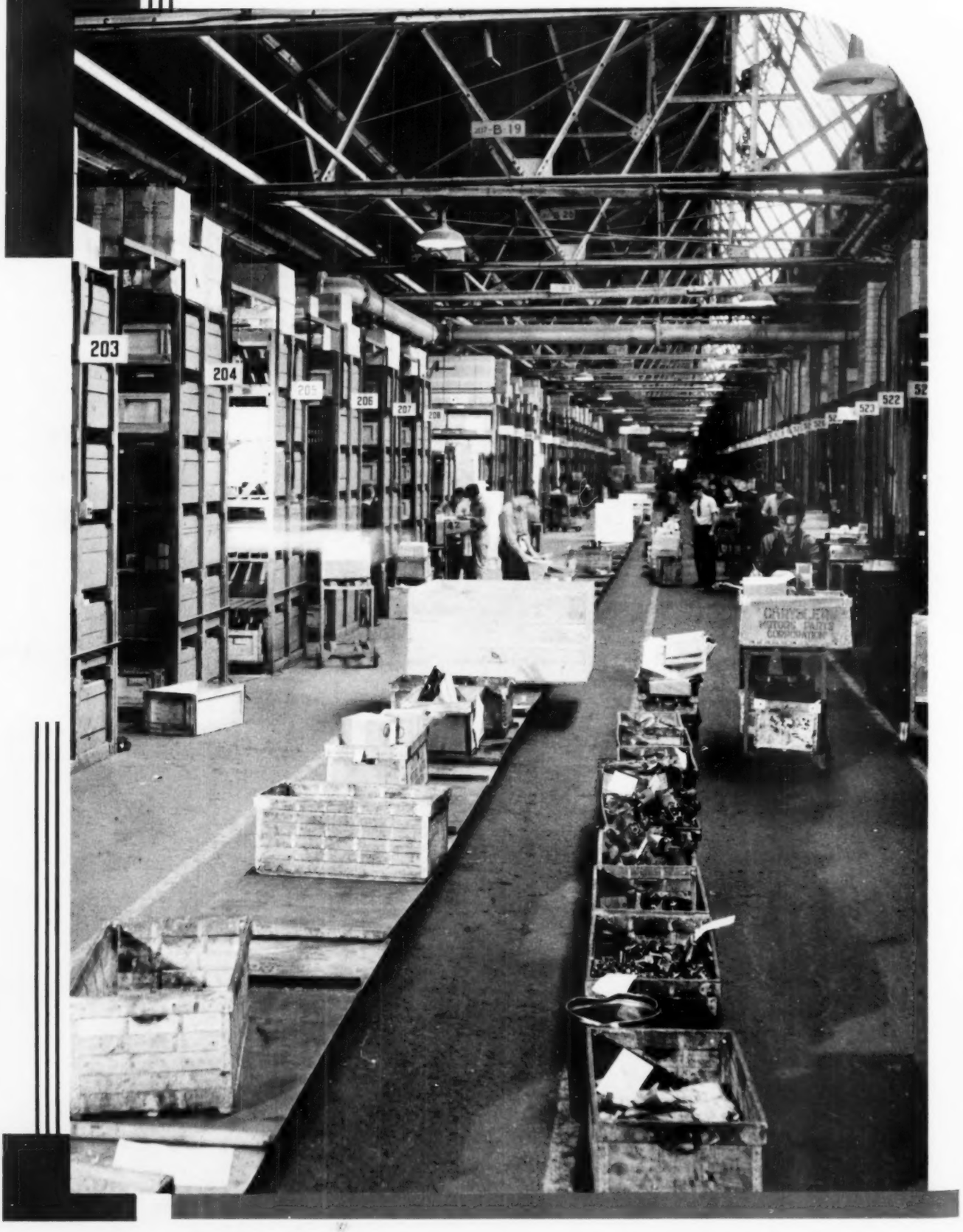
Close packing uses every available bit of space and forestalls shifting of the load at sea

Three to a box, motors are packed in crates moved along a conveyor



Associated Activities

Half a mile long, an endless floor conveyor carries 150,000 different service parts from storage bin to shipping dock



Supplying Service Parts

to Keep Customers Contented

SELLING A CAR or truck to a customer is only the beginning of the automobile manufacturer's job. His important task from that time on is to see that the customer is provided with prompt and efficient service and that he secures replacement parts of the same quality as those originally put in the vehicle.

Chrysler Corporation, to carry out the latter part of this responsibility to its car owners, has established a Parts Division, which comprises a plant at Highland Park having over 1,000,000 sq. ft. of floor space, a recently acquired plant in Marysville, Michigan, of 300,000 sq. ft. floor space, and additional warehousing facilities in the Detroit area of 300,000 sq.ft. With this manufacturing and storage capacity, it is in a position to furnish all parts which were used on any Chrysler-made passenger-car, truck, marine or industrial engine.

To supplement this parts service for car owners and dealers, the Chrysler Motor Parts Corporation has established parts depots or warehouses in 13 key cities throughout the United States. Each one of these parts depots carries a well-rounded stock of fast and medium-moving parts for all Chrysler-made vehicles. Slow-moving parts are quickly ordered for customers out of the master Detroit stock by teletypewriter service connecting each one of these points.

The parts for all Chrysler vehicles are originated by the Chrysler engineers. To coordinate the activities of the Engineering Department and the Parts Division, there is the Technical Records Department which not only keeps blueprints and master records of all the parts used on any of the vehicles manufactured, but also edits, for distribution to dealers, service literature such as instruction books, parts manuals and price books. All the new part or superseding part releases from the Engineering Department clear through this technical records group, who give this data to the Order Department, Merchandising Department and the Material Control Department.

The twelve depot stocks, as well as the master warehouse stock, are controlled in one central location, so that any temporary shortage of stock at any point in the United States can be filled from a nearby point when available. This department must also estimate the future requirements for any part of the vehicle, and before the vehicle goes out of production must order a stock on most of the parts on the basis of all-time requirements. This is done to get the most economical production run, which exists while the vehicle is being manufactured.

Keeping the Records

An individual card record is kept on each individual part in each depot or warehouse, on which are recorded the disbursements and receipts, so that accurate stocking can be maintained at all points. Over 500,000 cards are used to record these items. This department also issues approximately 350 requisitions per day to replenish stocks at various points.

Some parts are purchased outside and all of these are carefully inspected when they are received, and are then painted, or if necessary, dipped in vats of special protective greases.

At the Highland Park Plant, a gen-

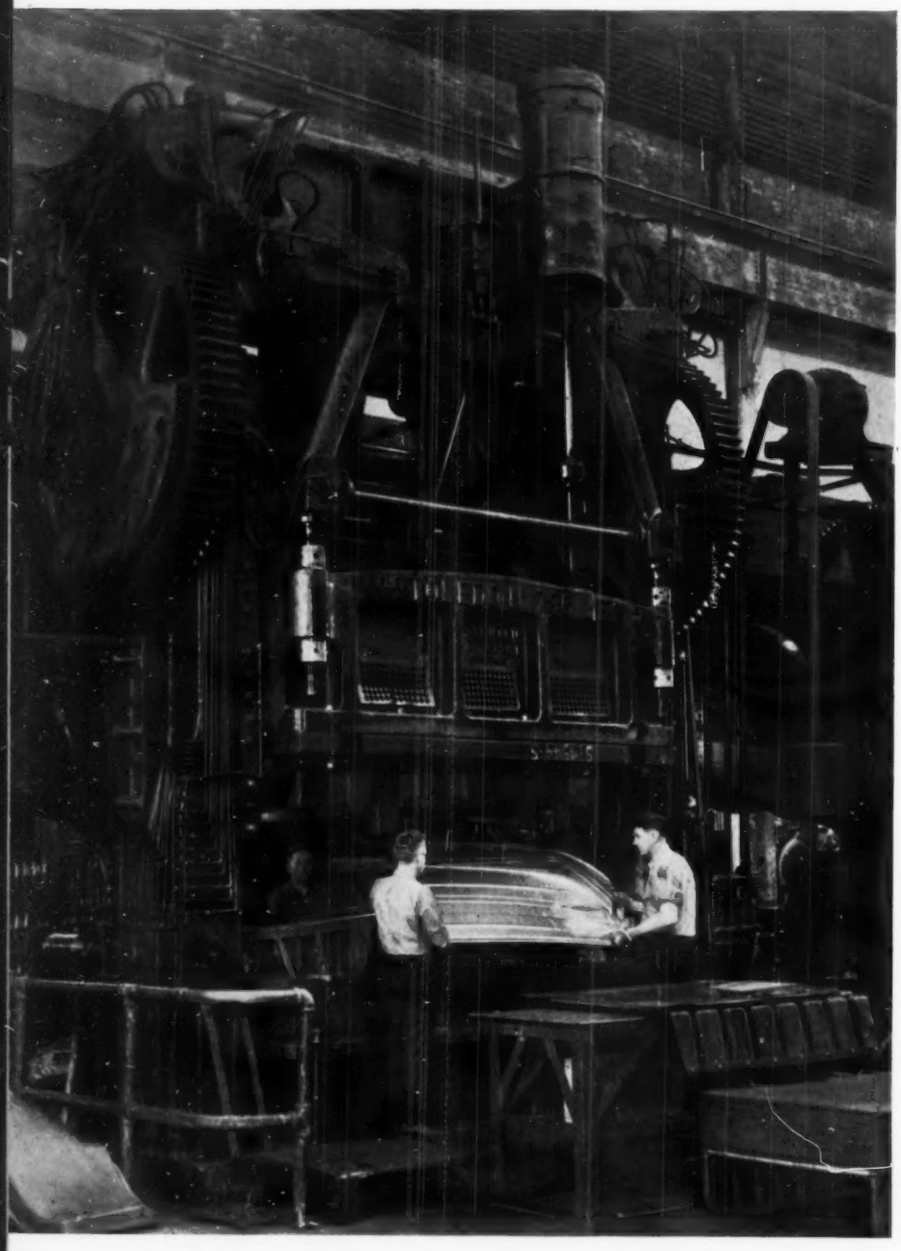
Each parts depot is hooked up with this teletypewriter headquarters room in Detroit. Parts thus ordered are shipped immediately to customers

eral machine shop, a gear plant, a stamping department, a paint and trim department and a polishing and plating department are maintained. In addition to these manufacturing facilities, a package department composed of 75 men and girls places thousands of parts in unit packages. Other related parts are put up in service packages so that a customer may order all the parts for one service job by one simple number instead of being forced to specify each individual screw and gasket involved in that service job. Parts are trade-marked with a copyrighted stamp, guaranteeing them as genuine Chrysler parts, since they are fabricated to Chrysler engineering standards for material and workmanship.

On the average 112,000 parts orders arrive each month at Detroit and the zone parts depots. Orders are received at the incoming mail desk of the Parts Order Department, where a complete register is maintained of each distributor and dealer of the Chrysler Corporation. Orders are then passed to "interpreters" or specifiers, who examine them for correctness. They have at their fingers' tips parts records that have been placed in a specially designed roller table in which are kept 17,800 specifying cards. These records show every part serviced, whether on a car or truck. Also, there is available a record of every car or truck built by the Chrysler organization, with the engine and serial number as well as other important data pertaining to that special vehicle. This record shows the style and type of trim, the color of the paint, the lock number, the town to which the vehicle was shipped, the factory in which it was made and the date of shipment.

After the items on the order have been scrutinized for correctness by the specifier, it is passed to the price and location desk. Here the correctly specified items are priced and the location in the parts warehouse is noted on the order. This information is taken from 13,500 pricing cards, which are again mounted in finger tip control roller trays. All of this information having been noted, the order is sent to fanfold typewriters for typing, after which it is approved by the Credit Department and sent to the parts dispatcher.

Tens of thousands of sheet metal replacement parts are produced annually at the Highland Park factory



Service Parts Production in 1935 at Highland Park Plant

28,000	pairs of front fenders
20,000	pairs of rear fenders
60,000	radiator shells
7,000	pairs of splash shields
6,000	pairs of running boards
87,000	gears
5,000	pinions
5,000	crankshafts
300,000	pistons
25,000	connecting rods
3,600	engines

In the Highland Park Plant, 8,600 ft. of pneumatic tubes connect the order dispatcher with all stations in the warehouse. Within 25 seconds after the order is put in the tube at the dispatcher's deck it is in the hands of a plant dispatcher, who immediately turns it over to a stock gatherer. When the parts have been picked out of the bins, they are placed on an endless floor conveyor one-half mile long, which takes them to the Shipping Department. The Shipping Department is also connected with the box and carton storage room by a 2,570-ft. overhead conveyor, which brings wrapping and

crating material for such parts as fenders, wheels and splashers.

The average monthly shipments amount to 4,150,000 lb. of material, and go to all parts of this country and to foreign countries. In order to visualize this figure, it would take 415 trucks carrying a 5-ton load to transport these parts each month, to service Chrysler Motors vehicles for their owners.

Slow-Moving Parts

Orders for slow-moving parts are referred to Detroit from the parts depots over the teletypewriter system and material is shipped to the customer from Detroit. This is further augmented by direct telegraph machines which bring in approximately 3,750 messages per month from dealers requesting direct shipments. All types of transportation are used to get the parts to their final destinations promptly and safely.

This makes up one of the largest institutions of its kind in the automobile industry and it is all maintained to give Chrysler-manufactured vehicle owners prompt service on their replacement parts requirements so that they can put their vehicles back into service as quickly as possible.

This is a small section of the marine-engine assembly line at the Jefferson Avenue plant in Detroit

Marine Engines — Geared and Direct

ENTERING THE MARINE industry only eight years ago, the Chrysler Corporation has already attained success in the manufacture of Chrysler marine engines which are built and sold by its Amplex Division. When Chrysler started building marine engines there were no small high-powered units of superior quality available at prices that would enable a person of moderate means to own a boat, which was necessary to stimulate the boating industry. The company was in production on several sturdy automobile, truck and motor coach engines and used them as a base for a marine engine, which was designed in such a way as to make use of the parts already available such as cylinder blocks, crankshafts, pistons, valves, tappets and other minor parts. This, with the high production tool equipment, fixtures and jigs, made it possible to produce marine engines of the finest quality on a production basis.

The first marine engine developed was known as the Chrysler Imperial, which was a 6-cylinder $3\frac{3}{8}$ x 5. This one was soon followed with a Royal model, which was $3\frac{1}{4}$ x 5. The performance and reliability of these engines soon created a demand for other models. Up to this time, Chrysler marine engines were mostly used in the smaller high-speed boat known as the runabout. The Chrysler Corporation realized the need for a more efficient and popular priced power plant for the smaller and medium size cruisers and fishing boats, and took the initiative in developing and pioneering the small bore engine with built-in reduction gears. This is, no doubt, accountable to a great degree for the development that has taken place in the boating industry in the last six to eight years. The advantages of the small bore multiple cylinder engines with reduction gears over the larger bore straight drive engines are outstanding. This type of engine is more efficient and saves in space, weight and first cost. With the various combination reduction gear ratios, it is also possible to have a wider choice of power plants.

The Chrysler marine engine line today consists of four engine models which are offered in both rotations, in straight drive types, and also with 2 to 1 and $2\frac{1}{2}$ to 1 reduction gears, making it possible for Chrysler to power practically every type of boat from a 16-ft. high-speed runabout to a 70-ft. twin-screw cruiser.

One of the problems is to schedule orders for a wide variety of trucks. Coming off the line at the right is a commercial express model, in the center a service truck and on the extreme left a commercial panel car

Dodge Trucks Offer 50,000 Combinations

SALES OF COMMERCIAL cars and trucks have recovered from the depression low even faster than the passenger car volume and this year promise to establish an all-time record. In the vanguard of this upswing in truck business has been the Dodge Division of Chrysler Corporation, which operates in Detroit one of the most efficient and best equipped truck manufacturing plants in the industry.

Demand for Dodge trucks has grown so rapidly that two enlargements of productive facilities have been necessary in the last two years. Today the plant is capable of building 500 units a day in a floor space of 546,000 sq.ft., utilizing every nook and corner to the best possible advantage. Work is conveyed through almost all operations, with overhead hoists to carry major parts from one assembly line to another.

Outstanding is a paint system for spraying bodies and sheet metal parts with synthetic enamel. Spray booths are of the down-draft hydro-filter type in which the air is so free from fumes that operators can work comfortably without the aid of masks or other protective devices. Other steps have been taken in the plant to insure safe and comfortable working conditions for employees. An extra-wide pit, for instance, has been installed under the final assembly line so that operators can have plenty of room in which to grease the chassis and work on the underbody.

One of the problems which the management has solved successfully is that of scheduling orders for a wide variety of models. Dodge manufactures a line of trucks ranging from one-half ton to three tons in capacity. Wheel-bases run from 116 to 240 in. Special cabs and bodies, as well as variations in important mechanical details, are numerous. Altogether, something like 50,000 combinations are produced, not to mention what are classed as "special orders."

Operations at the truck factory include the building of cabs and bodies of all-steel construction, electric and gas welding being freely employed in this work; fabrication of brake drums, brackets, levers and other parts of

special design for trucks; and assembly lines for the frame, chassis and mounting of bodies. Banks of finished materials and parts are located along the assembly line at the point of usage.

The chassis assembly conveyor, 655 ft. long with malleable chain of 6-in. pitch, moves at a maximum speed of 22 ft. per minute. The final assembly conveyor, running at right angles to the chassis line, is believed to be the heaviest unit of its kind in the industry. It is 455 ft. long and weighs 88,000 lb.

Much of the transportation of parts in process is done by means of an overhead monorail conveying system 2,550 ft. long. This system, for example, carries wheels through the painting and baking process.

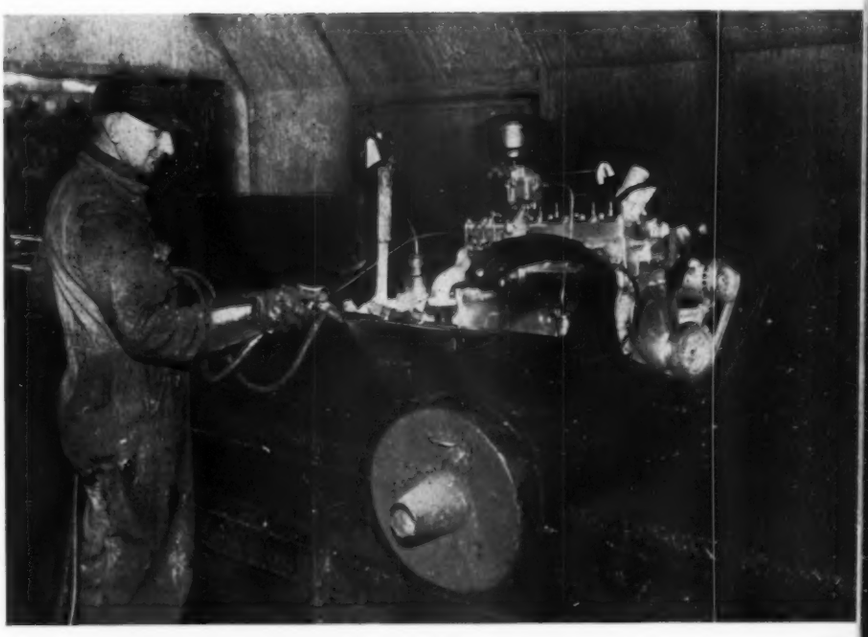
Bodies are built in the middle of the plant. Panel sides, cowls and complete bodies are assembled in massive metal jigs to insure accurate alignment. Bodies move from this department to the paint shop, then to the trim line and finally to the assembly line. Assembly of heavy-duty, stake and platform bodies is carried on in a separate department from which the work moves through the various finishing operations to the final assembly line.

Experiments are being made at the Dodge truck plant to salvage the overspray of pigment and filler of the synthetic enamel. In the body spray booths a curtain of low viscosity oil is flushed down a panel, washing the overspray into a trench the contents of which flow into a salvaging tank. The solids settle at the bottom of the tank and can be easily removed.

Synthetic enamel finish baked on truck bodies has such a high gloss that it does not have to be polished or handled after the painting process. To protect this finish, bodies (and also sheet metal parts) are fitted with special canvas covers as soon as they leave the paint shop. These covers are not taken off until the final inspection station is reached.

Chassis frames are sprayed in special booths so designed that the operators need not wear protective devices. There are two operators for each booth, one on the right side and the other on the left. This insures that the frame and its attachments will be sprayed all around.

Bodies emerging from the baking oven go to a cooling station where a draft of air from an overhead hood is blown on them. In this way they are quickly brought down to a temperature at which they can be handled in subsequent operations.

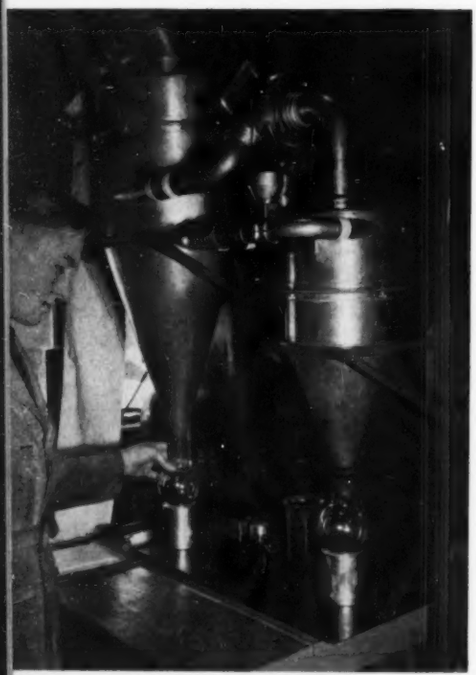


● Wheels are cleaned and dried in a two-stage washing machine and convection type oven

● Chassis frames are sprayed in special booths so designed that the operators need not wear protective devices

Automatic mechanically operated briquetting machine. Mixed material drops from a hopper into the die

Oilite bearings, with either graphite bronze or sponge iron bases, contain 35 per cent of oil



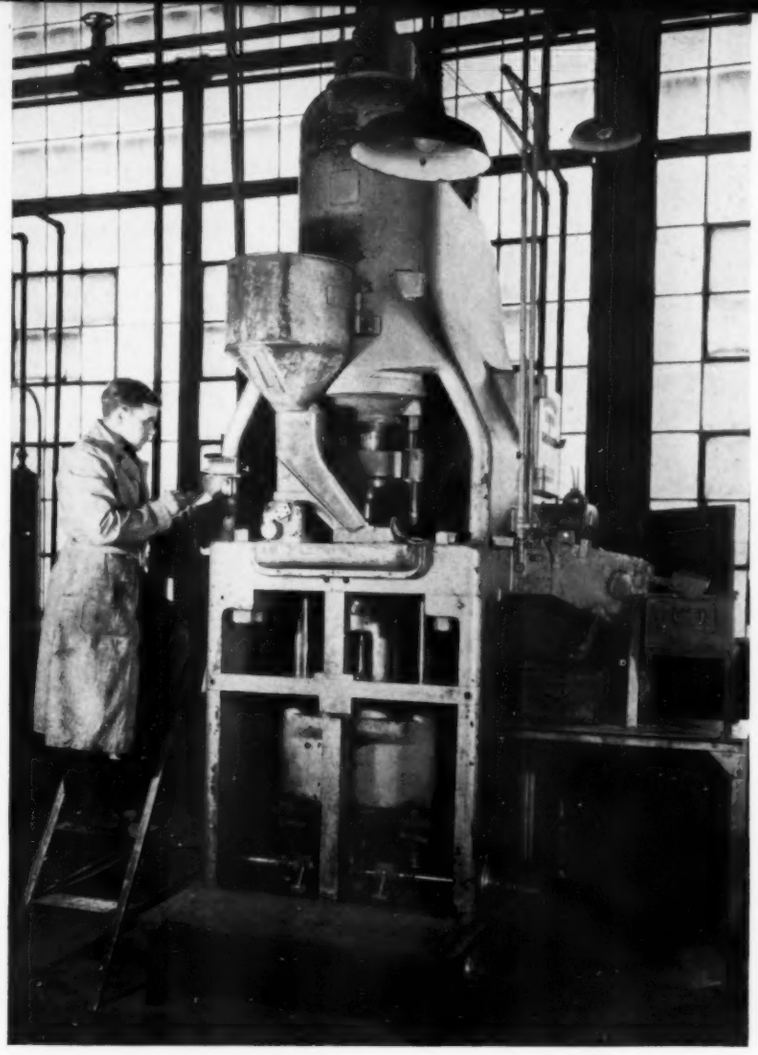
Powdered metal is weighed out in grams in these separators in the research laboratory

Bearings That

THAT BEARINGS in any product need oiling has been a generally-accepted fact, whether the product happens to be an automobile, a piece of industrial equipment or a household electric refrigerator. Probably more products fail in service because the owner or operator has neglected to keep them properly lubricated, especially when bearings are in inaccessible places, than for any other reason.

In recent years, however, development of so-called oilless bearings has shattered the traditional rule that all bearings must be oiled regularly. Chrysler Corporation, through its Amplex Mfg. Co. division at Detroit, has been a leader in the successful attempt to provide industry with bearings so impregnated with oil that in most cases they need no service attention after they are once installed. These bearings, known as Oilite bearings, contain 30 to 35 per cent of oil by volume, although they are seemingly solid.

Oilite self-lubricating bearings were first developed when Chrysler engineers in 1926 started experiments in an effort to discover a method of making bearings which could be used successfully on water pumps and clutch pilot applications on automobiles. Chrysler bearings are made from pure virgin copper in powdered form, to which are added tin and graphite. The actual analysis is 88½ per cent copper, 10 per cent tin and 1½ per cent graphite. These bearings on applications where the speed is low or the movement is of a slow oscillating



Some of the briquetting is done in this type of hydraulic press

Need Not Be Oiled

nature, perform satisfactorily under unit pressures of 5,000 lb. per sq. in. Heavy shock loads are likewise not objectionable.

For bearings subjected to extreme heavy-duty work, Chrysler engineers recently have perfected Super-Oilite, which has an iron base and can stand up under the unit pressures as high as 30,000 lb. per sq. in. Sponge iron, of high purity, imported from Europe because it is not available in this country, is employed in this product. The oil content is 35 per cent by volume.

Operations in the manufacture of Oilite bearings consist of (1) mixing, (2) forming or briquetting, (3) heat treatment, (4) impregnating with oil, and (5) finish sizing. The virgin material bought in powdered form is over 99 per cent pure. Rigid specifications govern the screen size, density, flow, structure and malleability. Super-Oilite bearings are made by the same process and have the same general characteristics as Oilite bearings, except that they have many times the strength of the latter.

Most of the materials going into Oilite bearings are so fine that even the finest screens cannot be used to measure and classify them, microns being employed instead. Because of the fineness of the particles, the materials (powdered copper and powdered tin) have a great affinity for oxygen. They are packed and shipped to Amplex, therefore, in hermetically sealed containers. Hazards of oxidation are so great that they cannot be stored safely for more than a few weeks.

Powdered metal is first checked for suitability, then weighed, mixed and screened. Equipment for this purpose is a tumbling barrel, mounted on a diagonal rather than a parallel axis, with an agitated screen below it.

Briquetting is done on both mechanical and hydraulic presses. The mixed material is poured into a hopper directly over the press. Operations are automatically timed so that when the lower punch of the die set is in the bottom position, the hopper discharge outlet opens and the powder flows directly into the annular space of the die. Then the hopper backs away and the upper punch of the die travels down, compressing the material into final shape. After the upper punch recedes, the lower punch knocks out the briquette and deposits it on a level with the die table. The hopper sweeps the briquette out of the way, the die space is again filled with powder and the operation repeated.

A die set consists of a die, upper punch, lower punch and core rod. All units are made of hardened alloy steel and are ground and lapped to the same finish and accuracy as plug and ring gages. Such precision is necessary, because if they were slightly over-size, they would not fit together. On the other hand, if they should fit too loosely, powdered material would pile up between the members and cold welding result. These tools, incidentally, have a relatively short life.

Heat Treating

Heat treating is a sintering operation in that the briquette is heated only high enough to melt the tin, which then combines with copper, forming a true bronze. The briquette retains its original shape during this process. As a matter of fact, the heat-treated briquette is virtually a phosphor-bronze bearing. Oilite bearings contain no oxides because of the purity of the metals used and because the heat treatment is applied under a reducing atmosphere.

Dry bearings being lowered into oil tank to be impregnated with oil. They soak up oil much as a sponge absorbs water

While standard briquetting pressure is 60,000 lb. per sq.in., it can be varied easily so that a product of greater density and less porosity or one of less density and higher porosity (or oil content) may be produced. Composition of the metal may be varied, if desired. Dry bearings, after heat treatment, are placed in a tank of lubricating oil where they soak up the oil very much as a sponge absorbs water. Impregnation is hastened by heating the oil to around 225 deg. F. After about ten minutes in the oil, the bearings are removed and allowed to drain.

The Sizing Operations

Bearings are sized on mechanical presses, which are equipped with dial feeds when a large production run is going through. Sizing tools resemble briquetting tools in that they consist of a die, upper punch, and lower punch or knockout. Tools are of hardened alloy steel, finished by being ground and lapped to very close limits.

Oilite bearings under load, it is claimed, operate along the principles of hydraulics rather than mechanics; therefore physical properties, such as tensile and compressive strength and hardness, are no criterion of their load-bearing capacity, life and merit. All kinds are in use, hundreds of standard sizes being available, as well as special sizes and shapes. They are specified for as many as 15 applications on some automobiles. Oilite is used in a score or more industries—airplanes, automobiles, boats, conveyors, electric motors, farm implements, food machinery, household equipment, pumps, machine tools, etc.

Oilite bearings are assembled with the same tools and equipment employed for cast bronze bearings. The inside diameter may be brought to final size by a sizing arbor, broach or burnishing tool after assembly. Another method, used on water pumps, consists of pressing bearings into place by means of a quick-acting power press and then sizing with a Bearingizer. Reaming is not as desirable as burnish-

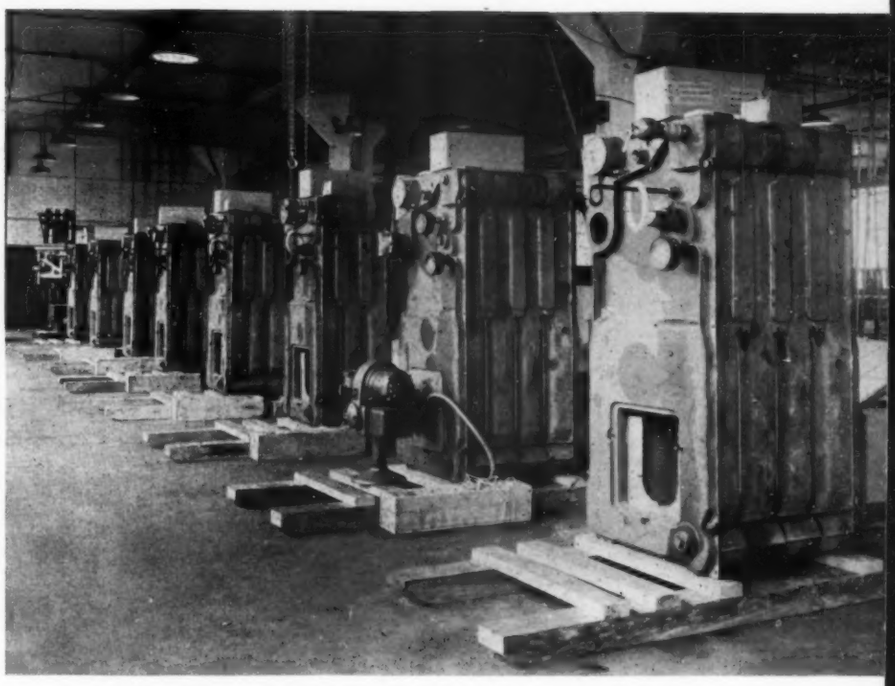
This type of mechanical press is used for sizing bearings when production is small

ing and does not readily provide the uniformity of size obtained with a sizing or burnishing tool.

If a housing contains an oil reservoir, it is not necessary to drill an oil hole into the Oilite bearing. The bearing will keep itself fully charged with oil and yet will not drip. Should the reservoir contain dirty oil, Oilite will act as a natural filter, and nothing but pure oil will reach the shaft.

Oilite bearings, it is asserted, are quiet in operation, have a co-efficient of friction much lower than that of cast bronze, a low wear factor, and permit high unit pressures. They have been used successfully where hardened and ground steel bearings have failed.

An unusual application is where a manufacturer of thrust ball bearings adopted Oilite retainers which tested perfect after 1,500,000 de-clutchings. A farm implement company ran an Oilite bearing 1,550 hr. on a magneto without adding oil, the estimated life of the magneto being 1,450 hr. Both shaft and bearing showed no wear at the end of the test. Many bearing problems which seemed impossible of solution have been licked by Oilite.



A row of boilers set up for assembly typifies Chrysler's Air-temp line of air-conditioning equipment

Conditioned Air —

Domestic and Industrial

CHRYSLER CORPORATION began experimenting with air conditioning equipment several years ago and for the past year and a half has been manufacturing and selling products in this rapidly growing market under the name of Airtemp, Inc. Behind the Airtemp organization are the entire mechanical, engineering and financial resources of the corporation.

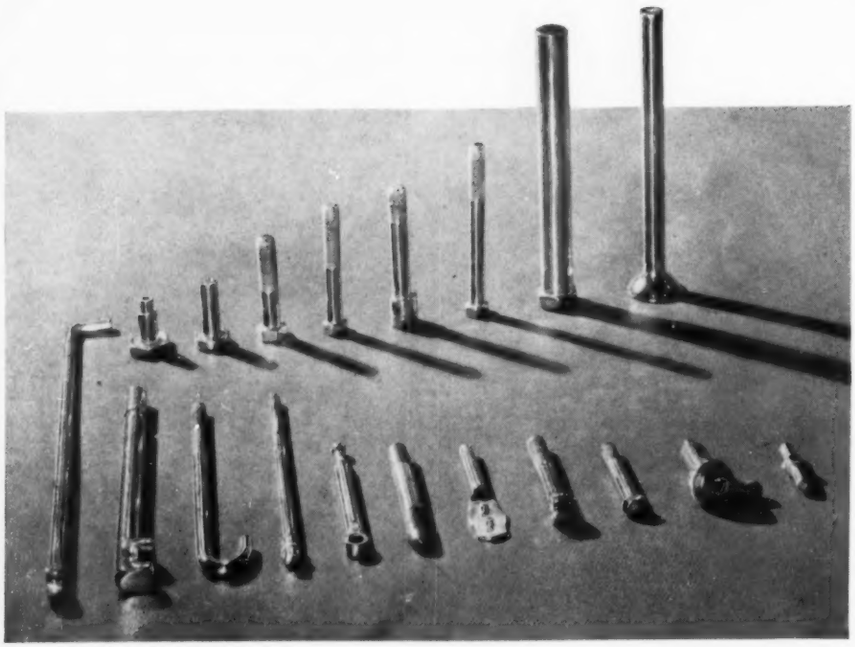
Airtemp, which has heretofore had its headquarters on Conant Road in Detroit, is active in making equipment for both summer and winter air conditioning, handling jobs which run from small half-ton self-contained units for single rooms and offices to the conditioning of office buildings, hotels, department stores, railroad cars and industrial plants. Early in June it will begin manufacturing in its own plant in Dayton where it will have 200,000 sq.ft. of floor space with ample room for engineering and production activities, executive and sales offices and shipping facilities.

The company is in the year-round residential air conditioning field. It builds various sizes of conversion oil burners and automatic heating systems; complete oil-fired and gas-fired boiler burner units; and complete air-conditioning units for heating, cooling, dehumidifying, filtering, ventilating and circulating air.

An interesting phase of Airtemp's growing business is that devoted to installation of air conditioning systems in industrial plants for processing purposes, such as maintenance of air at constant temperature and humidity in rooms where very fine precision work is done.

The personnel of Airtemp, Inc., has been recruited from the ranks of experienced air-conditioning companies. Distributors have been appointed in 25 key cities throughout the United States. These distributors in turn set up their own machinery to sell, engineer and install equipment.

Airtemp's products are developed and carefully checked and tested in well-equipped laboratories at Detroit. In these laboratories are sound-proof rooms for the checking of sound levels to insure quiet mechanical operation of the air-conditioning units. Means of eliminating vibration are studied and the beneficial results are incorporated in the company's products. Completed units are subjected to severe tests to make sure that they will stand up successfully under the most arduous service conditions.



Bolts

COLD HEADING IS an old operation that has been improved and brought up to a high state of development in the Chrysler plants. If a bolt or similar headed part is made by turning the shank down from a piece of stock the size of the head, there is a loss of material. Accordingly this process has been extended to a wide range of shapes and sizes that are not ordinarily considered in connection with cold heading.

The process itself is simple. A heavy ram holding the punch comes up against work held in a heavy die, and in one or two strokes upsets the steel to form the desired head. No stock is lost in this operation. In practice, however, the process involves more than appears on the surface. The metal must be studied to see how much it will flow without being heated, and the dies must be constructed to give the desired results.

In general, operations in this department may come under three heads:

1. The open-die method in which the work is fed through the die itself as the die is automatically opened and closed;

2. The solid die method in which the work is fed through an opening parallel to the length of the die, is sheared and carried to the die by an automatic arm;

3. The trimming die, which is a second operation with the work fed into a hopper. The part is carried down a chute, and picked up by a mechanical arm which holds it in front of the die. The punch in the ram strikes the part and forces it into the die. The trimming operation is to form hexagon, square or other shapes on heads upset in the first operation.

For most parts standard cold-heading stock is used in coil form. However, for some uses alloy steels are required. The brake shoe anchor bolt, for example, uses a chrome-nickel steel. Despite the tough stock employed and the fact that an eccentric head must be upset on this piece, a Waterbury Farrel machine turns out 50 bolts per min.

The connecting rod bolt, made of standard cold-heading stock, has a

● Time and material is saved by applying the cold-heading process to a wide range of parts

● *Right*—Metal flows properly only when solid or open dies are correctly designed

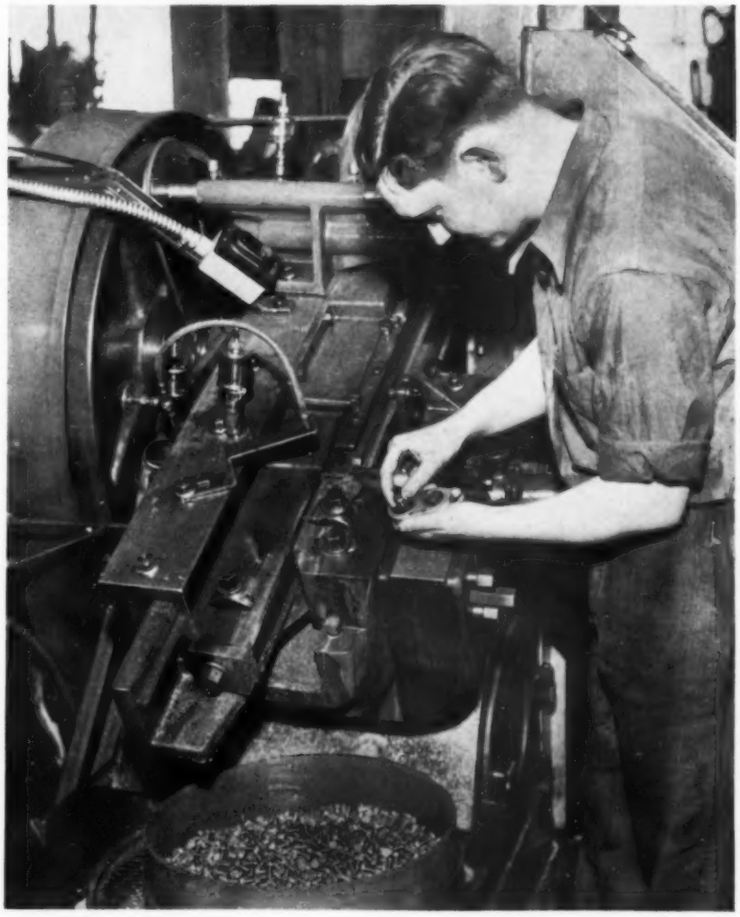
Are Headed and Threaded

head which is flat on one side and tapered on the other. It has also a small shoulder on the shank which permits grinding the section under the head for a body fit while the threaded end is slightly undersize for clearance. These are headed at the rate of 70 per min.

The cylinder head stud, which when finished is threaded at both ends, is first upset for about a length of 1 in., and ¾ in. of this length is reduced to original size by means of an extruding die with a Carboloy insert. The result is to leave a slightly larger central section against which the stud may be drawn tightly when assembled with the cylinder block.

The brake shoe adjusting bolt is first made from round stock with a round head 2½ times stock size which is trimmed to a hexagon in a separate operation. The trimming is done in a Manville machine at the rate of 44 per min.

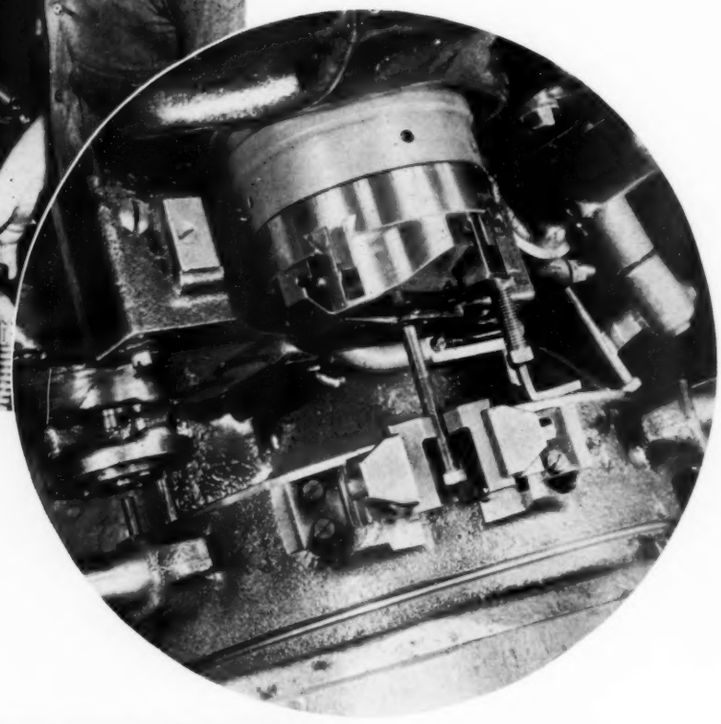
Not all the parts turned out in this department are bolts. For instance, the master cylinder connecting rod, which is used with the Chrysler hydraulic brake system, has the end bear-



● "Go" or "not go" is decided by limit gage as bolts come off the thread-rolling machine

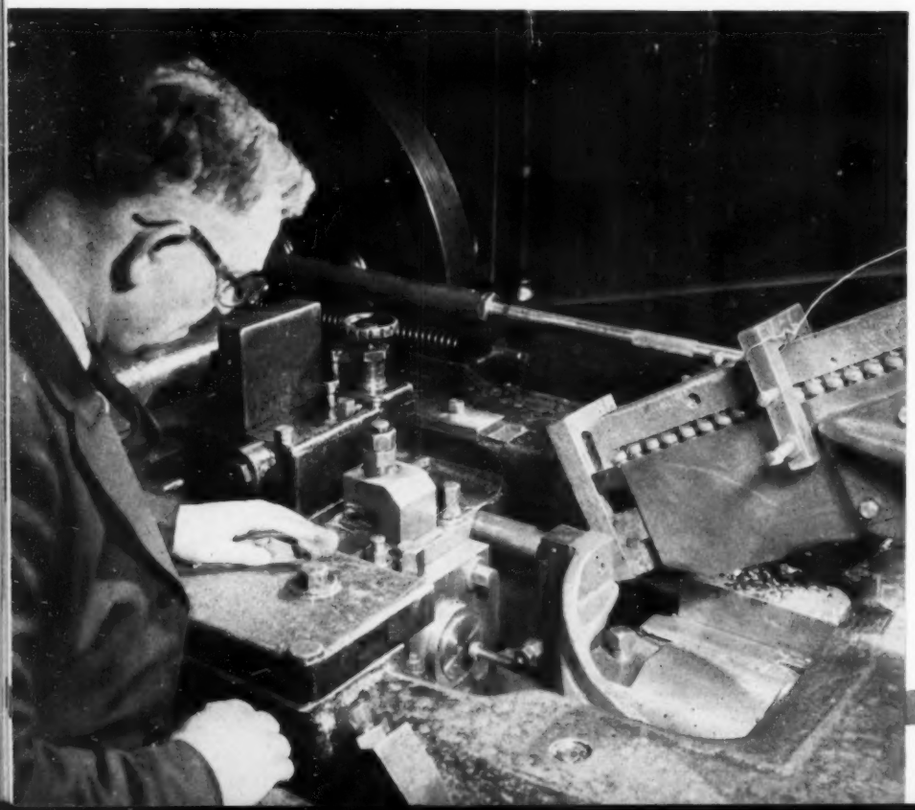
● Shanks are milled flat in a double straddle set-up

Heads upset cold and threads cut or rolled contribute to a mass output that is virtually a business in itself



● From the hopper to the chuck, a mechanical arm carries a bolt to be threaded and pointed

● Upset heads are trimmed in a hopper-fed machine



ing formed in it on a cold header. The head is trimmed and drilled in subsequent operations. Trimming dies are sharpened on a Heald surface grinder with the holes lapped to insure maximum smoothness of the surface. High-speed steel inserts are used in these dies.

So great is the variety of parts passing through this department that only a few can be illustrated. All in all there are 23 heading machines and 17 trimming machines installed here, some of which can handle up to 1-in. stock.

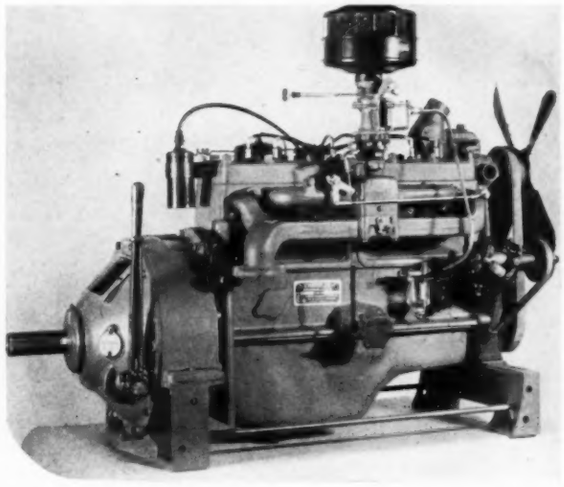
To keep up with the high production in the cold-heading department it is essential that a rapid method of threading be employed. Thread rolling has been found effective for this purpose and in addition has been de-

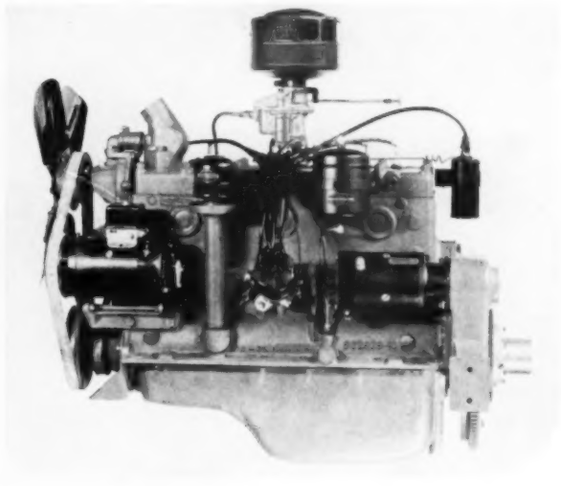
veloped to a point where the thread can be held to 0.002 in. in pitch diameter. The operation, which is very much like making butter balls between corrugated boards, produces a close-grained durable surface.

Work that cannot be handled in this way is threaded by cutting in Acme threading machines. Altogether 12 thread-rolling and 50 thread-cutting machines are used in this department. All machines are hopper fed. Recently two Landis threading and pointing machines have been installed which turn out work at a rate of 16 pieces per min. The parts are taken from the hopper by an automatic arm which places them in a revolving disk. After first being carried to the threading die and then to the pointing head the parts are ejected automatically into a pan.

When flat heads are to be milled a Newton milling machine with a large circular fixture is used. One clamp serves for four bolts which are arranged in a double row. Four cutters on a vertical spindle are set up to straddle the bolts as they pass between them. The machine operates continuously with bolts being removed and new ones loaded as the fixture revolves.

Cutting oil is used on these threading operations as well as on the automatic screw machines. Most of this was lost until two Tolhurst oil extractors were installed. Now 3300 gal. are salvaged a week. The oil is freed from bolts and chips by centrifugal action and is then transferred to a purifier before being pumped to the screw machines. This set-up, which paid for itself in 120 working days, is one more example of the attention to detail paid by the Chrysler organization.





Many standard automobile parts go into these 6-cylinder industrial engines. The one at the left is equipped with governor and power take-off; at the right, short coupled for direct drive

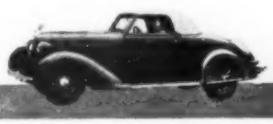
Engines for Industry

IT IS NOT SURPRISING that the success achieved by commercial vehicles powered with Chrysler-built engines resulted in a demand for engines suitable for industrial purposes. In 1931 the Amplex Division of Chrysler Corporation announced a line of industrial engines, ranging from six-cylinder models with a displacement of 201 cu.in. to eight-cylinder models with a displacement of 324 cu.in.

The horsepower and torque characteristics of these engines at speeds ordinarily encountered in the industrial field made them desirable for driving pumps, generators, industrial tractors, agricultural machinery and other industrial machinery classifications.

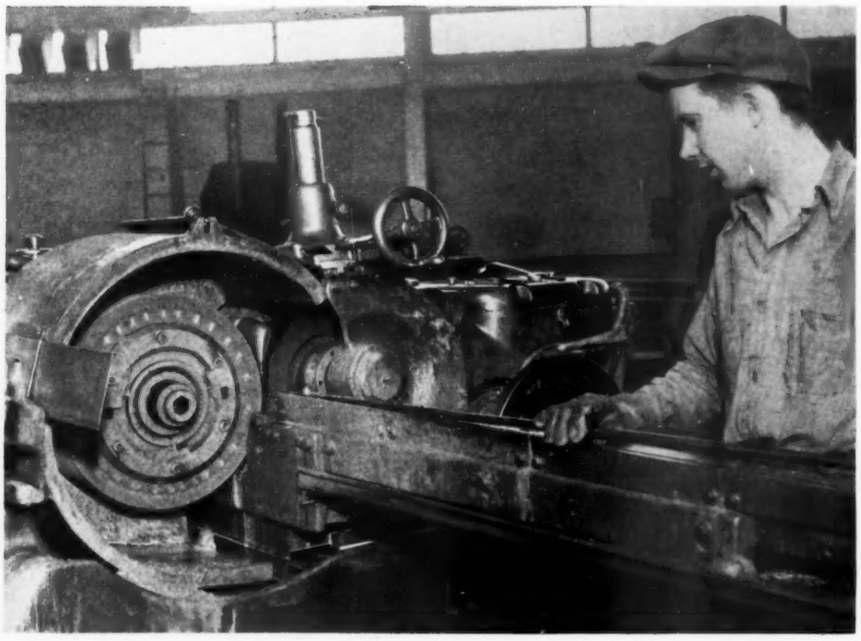
The basic design of the automobile engine was not changed for industrial work. Full advantage was taken of the modern production methods used by Chrysler Corporation. In fact, the use of material and parts going into the automobile motor has simplified the problem of field maintenance. The industrial engine user is protected against costly delays awaiting replacement parts by the location of Chrysler parts depots at strategic points throughout the country. There also are modern service stations operated by Chrysler dealers in nearly every town and city. The personnel of these stations consists of factory-trained service men.

Development by Chrysler of a process for bonding rubber to steel and the application of "floating power" for mounting engines are well known. As a result of the patented bonding process, it has been possible to design a flexible coupling for engine-driven units such as pumps and generators. The coupling compensates for slight misalignment between the engine and driven unit and, because the coupling space requirements are relatively small, compactness in unit design is possible.



Coiling Springs

for Independent Front Suspension



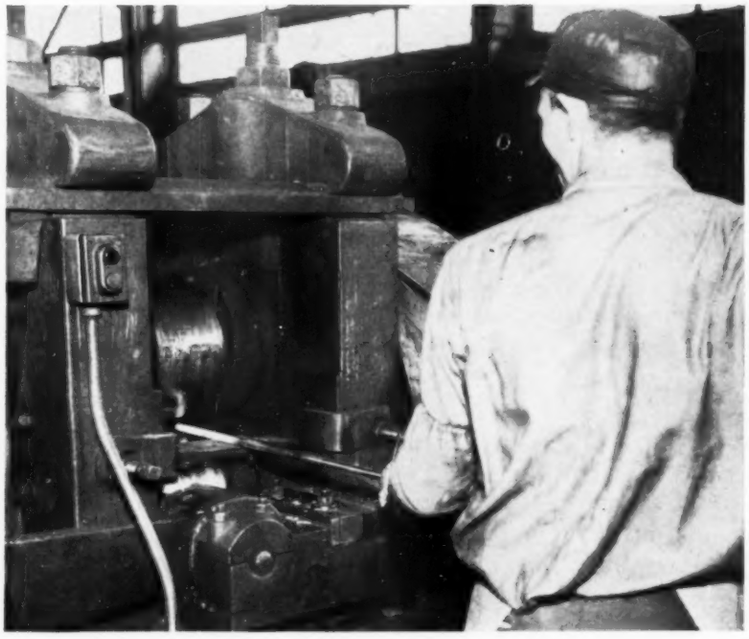
● Bars are rough and finish ground on Cincinnati centerless grinders set up in tandem

● A burnishing operation follows the centerless grinding

COIL SPRINGS for Chrysler and De Soto Airstream passenger cars are made in a special department at the Dodge forge plant in Detroit which contains equipment of the latest design. From the time that Amola steel in the form of cold-drawn bars 138 to 145 in. long enters the department until finished coil springs are ready for shipment to the Chrysler-De Soto factory, precision production is the rule. Sway eliminators for Chrysler-built cars also are made in this department.

Much of the machinery and heat-treating equipment was specially designed for the manufacture of coil springs, which are used in connection with independent front wheel suspension. Spring steel coming into the department is put immediately through a straightening roll to make sure that it will be perfectly straight for the

From straightening to grinding, from coiling to enameling, springs are formed in equipment that is largely single purpose and automatic



● **Both ends of each bar are pointed in an interrupted roll machine**

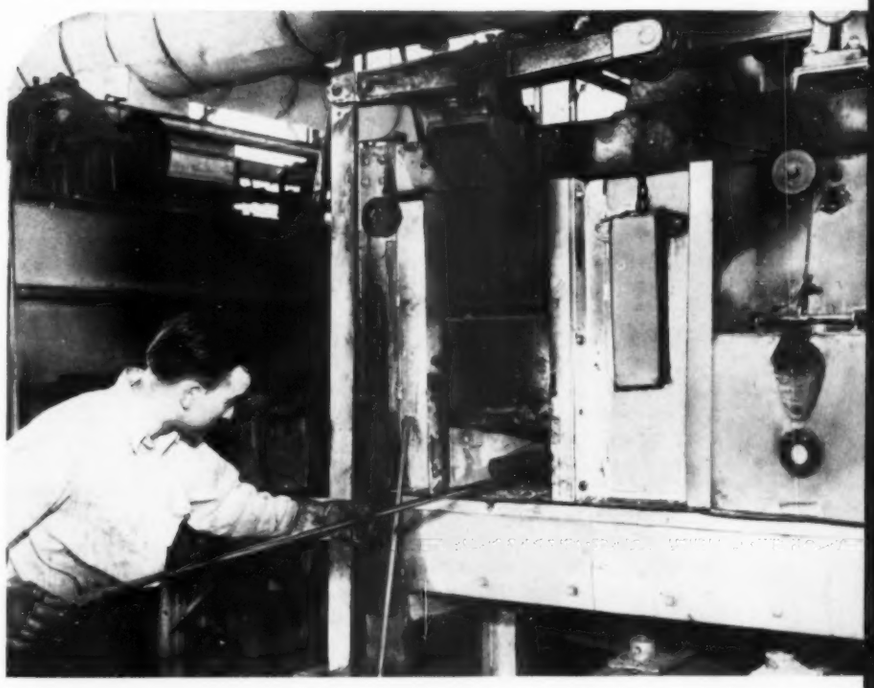
● **Bars being fed into walking-beam type of gas-fired furnace to be heated prior to coiling**

grinding operation which follows. It then is carried on a belt conveyor to a battery of Cincinnati centerless grinders set up in pairs, one for the preliminary grinding operation and the other for the finish grind.

Rough grinding is done on a large No. 3 centerless grinder using 24x6x12-in. wheels, and finish grinding on a No. 2 centerless machine employing 20x6x 12-in. wheels. Both wheels are 60 grit, grade H, aluminum oxide abrasive wheels of the Carborundum Company. The fixture or unloading device located between the rough and finish grinding machines supports the leading end of the bar emerging from the long bar attachment until it is kicked out of the latter by the bar directly behind it. When the bar is completely out of the long bar fixture and into the unloader, the total weight of the bar causes the cradle to drop as it is held in position by a spring adjusted to hold about 75 per cent of the total weight.

When the cradle drops, the bar rolls down the ways into position for insertion into the long bar attachment on the succeeding machine. After the bar drops, the cradle is pulled back into position by the spring already mentioned. The unloaders are adjustable so that they may be lined up with the long bar attachments of the machines. Similar devices are placed at the end of the finish grinding machines to hold the bars until they can be removed and placed on the outgoing conveyor.

Production rate of these machines is 12 ft. per min. gross, or 9 to 10 ft. per min. net of finish ground bars per pair of machines. Bars, which are 11/16 in. in diameter, are held to 0.002 in. on



rough and finish grinding, to 0.001 in. for straightness, and to 0.001 in. for roundness. From 0.015 to 0.017 in. of stock is removed in the grinding operations.

From the centerless grinders the stock is taken by belt conveyor to a special burnishing machine and thence to a conveyor-fed gas-fired bar and heating furnace operated by four low-pressure burners. The furnace itself is 8 ft. long, 20 in. wide and 10¼ in. high, a chain conveyor outside the furnace moving the bars through the furnace. Eight inches of the bar are heated at 2000 F. prior to having the end pointed in an interrupted roll machine. The other end of the bar is heated in a furnace of similar design.

● Spring after being coiled. The mandrel is backed out by air pressure and the coil spring falls free

● Each end of each coil spring is faced in a Gardner grinder equipped with double-end fixture holding four springs in each end

Following the pointing operation, the entire bar is placed in a walking beam type of furnace, the walking beam carrying the bar through two zones at a top temperature of 1750 F. The furnace has ten low-pressure gas burners. Work is discharged automatically from the side of the furnace. The tapered end of the hot bar then is fed by an operator with tongs into a coiling machine; after coiling, the mandrel is backed out by air pressure and the coil spring, about 12½-in. long, falls free.

The spring is placed in a gas-fired hardening furnace on an alloy steel belt conveyor and heated to 1550 F., finally passing through a cooling zone. The furnace, which is 14 ft. 10½ in. long, 52 in. wide and 13 in. high, is operated by 12 low-pressure burners designed for 530 B.t.u. gas. Emerging from the furnace, springs are quenched in a special oil quenching machine, after which they are carried through a gas-fired draw furnace on a slat-type conveyor. This furnace resembles other furnaces in the department except that it is larger, being 38½ ft. long.

At the discharge end of the furnace, springs drop automatically into a water bath. They go to a special internal wire brushing machine to be cleaned and are taken to Gardner grinders to have each end faced. Each spring is tested 100 per cent. Operators then hang the springs by hand on an overhead monorail conveyor to go through an overhead spray booth where they are sprayed automatically with enamel. Still on the conveyor, they move through a baking oven, the heat for which is provided by the exhaust heat from the hardening and drawing furnaces. After the enamel has been baked on, the springs are ready for shipment.

Motors AND OTHER MATTERS

Detroit is humming beehive . . . Bonus payments expected to be stimulus . . . Small car rumors persist . . . Plants letting out tool work . . . More stainless steel to be used . . . Diesel and steam engine experiments are under way

BURNHAM FINNEY
Western Editor

DETROIT—With car production tenaciously clinging around the year's peak of 115,000 units a week, and with most companies ordering full speed for 1937 models, Detroit is a beehive of activity. While operations will continue at a high level this month and probably next, there are signs that a tapering is near in releases of steel and parts. Fisher Body is reported to have bought most of its steel requirements through July. Ford, which is understood tentatively to be planning on building a total of about one million of its 1936 models, already has steel contracted for up beyond 900,000 units, so remaining purchases won't be heavy. Incidentally, Ford is understood to have made 665,000 cars and trucks of the current series up to May 1.

Although general opinion holds that summer sales of passenger cars will be very good, sales executives have their fingers crossed, hoping that the veterans' bonus will furnish the necessary stimulus. Some companies are dashing along at breath-taking speed, with no signs of curtailment ahead. Chevrolet is still building nearly 140,000 units a month and Ford over 120,000. Chrysler, having assembled about 116,000 units in April, is still crowding its all-time high mark.

$400 Automobile

Reports persist that a leading car manufacturer is getting ready to put on the market a small car in 1937. Its pending tooling program is large. Presumably this car will sell for about $400 and will be full-sized. The failure of Austin indicates that Americans will have little to do with bantam cars. The success of the Standard Chevrolet, on the other hand, points to a substantial market below present price levels, which is waiting for some company to cultivate.

The industry still is letting out tooling work for new models. Most die orders have been awarded, but local shops specializing in tools, jigs and fixtures are on slack schedules. Erroneous word got around among the automobile companies that jobbing shops in the Detroit district were loaded with work and couldn't take on any more. When these shops found out that business was about to go to distant cities, they conducted a hasty survey which showed that only 50 per cent of their capacity is now engaged. They passed on this information to car makers, and pending work will stay here.

Slowness Lost Business

Some equipment builders lost business recently because they could not make deliveries in less than four to five months. Chrysler is about to establish a heavy stamping department at its Wyoming plant, where an addition is being constructed. Around $175,000 is reported to have been spent for new presses. De Soto next year will probably assemble at this plant, heretofore used principally for storage of parts built ahead of assembly line requirements. Chrysler is said to be concentrating effort on strengthening De Soto, weakest of Chrysler divisions in volume.

A number of companies are playing with automatic transmissions, but few will have them on next year's cars. One General Motors make counts on going to copper-lead bearings, as used in airplane engines. It is now putting these bearings into a limited number of cars daily. Ford is reported satisfied with cadmium-silver bearings which it will retain in 1937. The overdrive is due for increased recognition, it appears.

Stainless steel will be used next year for more parts than ever before. It is especially favored for exterior moldings. The stainless steel people are thinking of the day when their material may be widely employed for automobile engines. Why not a light engine, possibly with aluminum and stainless steel combined to advantage? The cost of the finished engine, they contend, would be no more than present-day cost, in view of the lighter weight and elimination of much machining as compared with cast iron.

Steam Engine Experiments

While General Motors is setting up a diesel engine experimental division at the Cadillac plant, having spent about $150,000 for machinery and accessories, one of the divisions of the corporation is known to be experimenting with a steam engine designed for bus or truck service. Chrysler is reported to have developed a diesel engine for trucks which has been given grueling road tests for months with satisfactory results.

There will be a bigger volume of large sheets specified in 1937 because of adoption of the all-steel top by more companies, but the actual dimensions of the steel probably won't exceed present sizes. The expected swing toward the Zephyr type of body construction will be favorable to the use of large sheets. It also will mean much to makers of welding equipment.

While it isn't a matter of immediate concern to the steel industry, one should not take too lightly the threat which plastic materials hold of supplanting steel some day in automobile bodies. Henry Ford is working toward that end. One prominent production executive outside the Ford organization believes a plastic body, with requisite strength and durability, is not a pipe dream. He says: "Within a relatively short time, bodies have gone from wood to steel. Why not to plastics?"

Meanwhile steel bodies are coming into their own. Fisher Body is the last to capitulate, abandoning composite wood-and-steel construction for all-steel bodies for 1937.

The Canadian government has removed the duty on American machine tools for the automobile industry which are not now being made in the Dominion. The purpose apparently is to induce companies to make more car parts at their Canadian plants rather than build them in this country and ship them to Canada for assembly. Equipment makers are hopeful that the new ruling will result in purchases of machinery for Canadian factories.

Elected Cincinnati Miller Vice-President

SOL EINSTEIN

Since 1920 chief engineer of Cincinnati Milling Machine Co., Cincinnati, SOL EINSTEIN, left, has been elected a vice-president of the company. He started with the company in 1903 as a tracer, and advanced through various executive capacities to head of the engineering department. His work is principally concerned with special engineering and patent problems

Domestic Machine Orders Brings Index to New High

April Tool Business Advances 20.4 Points to 125.7, Led by Domestic Gain

Spurred by a sharp increase in domestic business, machine-tool orders for April reached the highest point of the year, the National Machine Tool Builders' Association index touching 125.7, an advance of 20.4 as compared with March. Domestic orders showed a 21.9-point gain over the last month total, figures submitted by 148 companies showed.

Averaging the domestic business for the first four months of the year, 1936 business to date is 84 per cent better off than it was during the first four months of 1935. The outlook is promising for the rest of the summer, the association reported. (See table below.)

Conference Board Plans Social Progress Forum

Theme Announced for 20th Annual Meeting on May 28

Ralph T. Flanders, president, Jones & Lamson Machine Co., Springfield, Vt., will be one of the speakers at the Twentieth Annual Meeting of the National Industrial Conference Board, Inc., May 28, at the Waldorf-Astoria, New York. Mr. Flanders, a past-president of the American Society of Mechanical Engineers, will discuss the place of business in the forum on the meeting's theme, "The Elements of an American for Social Progress."

More than 500 leaders in industry, commerce, finance and the professions will attend, according to Dr. Virgil Jordan, president of the Board.

GUN EXPERT DIES

Brig. Gen. Dickson, Watertown Arsenal Builder and Commander, Is Dead

Brig. Gen. Tracy C. Dickson, 67, retired army ordnance expert, and builder of the Watertown, Mass., arsenal, died May 17. For six years commander of the arsenal, he retired three years ago.

During the Spanish-American war he supervised manufacture of Springfield rifles, and was appointed inspector of shops from 1910 to 1914 on the building of the Panama Canal. Assistant Chief of Ordnance when the world war broke out, General Dickson was assigned to supervise munitions manufacture. He was soon assigned the task of building the modern factory at Watertown, and with Dr. Frederick C. Landenberg, developed centrifugal casting of guns and perfected many steps in ordnance manufacture.

SCANNELL HONORED

Buick General Manufacturing Manager's 30th Anniversary Celebrated

CHARLES T. SCANNELL, general manufacturing manager of the Buick Motor Co., Flint, Mich., was honored recently on the thirtieth anniversary of his connection with the company.

TRAILER OUTLOOK GOOD

The Covered Wagon Co., Mt. Clemens, Mich., has announced its second plant expansion within a month. The company builds house-type trailers.

AUTO-LITE EXPANDS

Bay City Mfg. Co. Is New Subsidiary For Making Automobile Parts

Electric Auto-Lite Co., Toledo, will establish a subsidiary plant at Bay City, Mich., under the name of the Bay City Mfg. Co., to manufacture automobile parts. It will occupy the former plant of the Wildman Rubber Co. Products will include rolled metal and molded plastic parts and lithographed dashboard dials.

ADDS PARTS PLANT

AC Spark Plug Co., Flint, Mich., has established a second automatic screw machine and small parts processing plant.

Table I—Index of Orders

Based on Volume of Shipments for 1926

Month	Index of Orders: Domestic	Foreign	Total	3 Months' Average Index	% Foreign to Total Orders
1935—May	57.3	16.0	73.3	67.1	21
June	75.5	15.6	91.1	76.7	17
July	82.5	37.3	119.8	94.7	31
August	78.2	47.6	125.8	112.2	37
September	54.1	25.9	80.0	108.5	32
October	79.5	23.4	102.9	102.9	23
November	73.2	19.4	98.6	93.8	19
December	78.1	20.2	98.3	99.9	21
1936—January	95.7	15.1	110.8	102.6	14
February	99.8	12.3	112.1	107.1	11
March	89.0	16.3	105.3	109.4	15
April	110.9	14.8	125.7	114.4	12

Table II—Distribution of Orders

Average Indexes of Individual Companies	Companies in Per Cent of Total Number Reporting: 1935, by Quarters: 1st	2nd	3rd	4th	1936: 1st	1936: April
200-up	402	5.8	14.2	11.3	13.0	17.6%
100–199	12.5	15.8	22.1	24.3	24.6	34.4
60–99	16.9	22.0	17.2	21.7	22.4	16.2
20–59	39.6	31.2	31.6	27.7	26.5	23.0
Less than 20%	26.8	25.2	14.9	15.0	13.5	8.8
	.	100.0	100.0	.	100.0	100.0

Watching Washington

Conventions call, but House tax bill is too much for Senate to swallow . . . Many metal products benefit by French treaty . . . Navy expenditures will aid heavy industries

WASHINGTON—Within sight of the finish mark, chafing at the bit to get into preconvention jockeying for political advantage, senators still could not bring themselves to take the hurdle of the House tax bill. In the face of the factual evidence piled up against the principles advocated by the President, which the House so readily swallowed, the Senate Finance Committee was compelled to make radical revision in the measure. The present draft cuts the undistributed profits tax to a flat 7 per cent, boosts the corporate profits tax to 18 per cent and raises the normal individual income tax from 4 to 5 per cent.

Opposition gains its strength from the fact that the House bill was particularly vulnerable. Careful scrutiny (which the House failed to give it) showed that the measure was unsound, would work all sorts of hardships, particularly on the little fellow, would let many of the big fellows escape and, worst of all, simply would not produce the revenue required.

Lind Offers Evidence

Typical of the damning evidence against the soak-the-surplus provision was that offered by Herman H. Lind, general manager, National Machine Tool Builders Association. Mr. Lind pointed out that in the capital goods industries, and particularly in the machine tool industry, cyclical fluctuations are severe. Reserves are essential so that companies in these industries can use profits from good years to stay in business and retain their key men when a depression hits them. In addition the need for continued research and development work during slack periods calls for higher proportional reserves than in consumer goods industries where major fluctuations are seasonal rather than cyclical. In short, capital goods firms under the proposed provision would be penalized because of the nature of their business which requires repeated building up and depletion of surpluses.

One threat of notoriously unsound legislation was avoided when the House snowed under the Frazier-Lemke bill calling for the issuance of $3,000,000,000 of greenbacks for farm refinancing. While this probably removes the last inflation threat from the current Congress, the fact that proponents of the bill were able to muster sufficient strength to bring it to the House floor is significant. Further struggles with revenue raising abetted by continued federal spending may make the threat more ominous another year.

Exports to France Aided

Secretary Hull made a dent in French nationalism by his recently signed bilateral treaty which should have beneficial effect on the exporting of certain metal products to that country through reduction of duties and easing of quotas. Chiefly affected in this group are automobiles, auto parts and office machinery. A 50 per cent cut was put into effect on passenger auto chassis with liberalization of the quota. Supplementary quotas were granted on cars with bodies and for bodies and parts. Refrigerators, radios and tubes, typewriters, tractors and certain agricultural machinery enjoy a tariff decrease from six to two per cent and will be admitted to France in larger quantities.

Other concessions include a long list of articles insured against increased duties, granted reduced rates or supplementary quotas. Nearly 21 per cent of U. S. shipments to France will be benefitted, which in 1935 had a value of nearly $25,000,000. The U. S. granted reciprocal favors on perfumes, laces, French wines and liqueurs.

The French treaty is the thirteenth granted, the fifth in Europe, since the policy of stimulating foreign trade went into effect. Another with Finland will be signed shortly, and negotiations with Spain are well advanced. An agreement with Costa Rica is almost ready for announcement.

Heavy industries will be aided by a good slice of the $244,000,000 available for 1937 "to bring the Navy up to treaty strength" as authorized by the Vinson-Trammell bill. The estimate is that 500 concerns, 19,000 workers, will be directly affected. Under the measure two heavy type cruisers will be finished in 1937, one in 1938, two light cruisers will be completed next year, five in 1938, and one each in 1939 and 1940; 37 destroyers will be finished in 1937, fifteen in 1938, and twelve each in 1939, 1940 and 1941. In 1937 nine submarines will be completed, five in 1938, three in 1939, six in 1940 and four each in 1941 and 1942.

To this will be added two aircraft carriers in 1937 and one in 1938. Beyond the figures for "treaty strength" ships is the probable authorization of two capital ships, plans for which have already been started. In addition the Navy will have under construction an auxiliary fleet of tugs, supply and hospital ships to a total of 200,000 tons at a cost spread over ten years of $175,000,000.

Already started, the aviation part of the program calls for spending $47,000,000—about $33,000,000 for new construction and the rest for maintenance and repair.

Since the Navy uses the best materials and insists on its own specifications, much of the material must be made especially for the job which means that an enormous amount of plant capacity will be brought into activity. The program will provide employment for skilled machinists, electricians and other artisans, bringing many back to their trades.

Where Navy Dollars Will Go

Boilers and engines	$2,300,000
Steel (mills)	14,000,000
Steel (foundries)	1,500,000
Heavy machinery	25,000,000
Machine tools	400,000
Tubing	1,400,000
Electrical cable, wire	800,000
Wire rope	300,000
Radio and wireless	1,850,000
Electrical apparatus	3,000,000
Heat insulating materials	350,000
Chemicals, etc.	2,000,000
Precision instruments*	450,000

* This amount probably will be augmented by the navy's aviation program.

Capitalism, Not 'Political Receivership,' Can Provide Prosperity, Dr. Frank Says

Political leadership must not become the economic receiver for American enterprise, Dr. Glenn Frank, president, University of Wisconsin, told the 34th Spring Convention of the National Machine Tool Builders' Association, May 11, at Edgewater Beach Hotel, Chicago.

"I have no faith in the capacity of political government to give us either stability or progress when it undertakes to run the whole show, whether it be the agricultural or industrial show it sets out to run," he said.

Decrying attacks on capitalism, he differentiated between "false capitalism," which he said is dying out, and "true capitalism," which is courageous, flexible to meet changing conditions, and is competitive on the basis of efficiency.

"The shortsighted element among private enterprises plus foggy-minded politicians have been jointly responsible for making great areas of American capitalism something less than it is," he said. Together, shortsighted business leaders and radical politicians have fostered measures to guarantee profits; they have tried to fix prices at artificially high levels; they have tried to subsidize weak and inefficient units of our economic life, and have tried to strangle fair competition of excellent management, he found.

Flays Demagogues

To solve the problem of the proper relation between the state and private enterprise, this country must, at all costs, preserve a self-governing democracy, he declared. Flaying the demagogue of both the reactionary and radical schools of thought, he said that business leadership must use, instead of sabotage, "the productive instruments we have invented and shall invent to provide abundance for the masses."

"The millions in this country hunger for the advantages that this age of science, technology and power production can bring to them. More goods at lower prices, not fewer goods at higher prices, is the only defensible goal of an age of science," he said.

"Science and the machine have brought us to the threshold of a social millennium, but to date we have lacked the wit to unlock the door. The current mania for repressing, restricting and reducing our maximum productive capacity must not be allowed to blight the buying power of the millions, and must not be permitted to make poverty the permanent heritage of these millions," he declared.

During the deliberations of the two-day convention optimism was practically unanimous among the members. President Norman D. MacLeod reviewed some of the industry's problems and discussed the gains made during the past twelve months.

L. W. Scott Alter gave a clear and comprehensive outline of the work of the committee which visited Washington in opposition to the proposed tax bill. He was followed by Herman H. Lind, general manager, who supplemented Mr. Alter's report. He displayed the medal awarded the N.M.T.B.A. by the American Trade Association Executives for outstanding work as a trade association.

Dean H. L. McCarthy, DePaul University College of Commerce, Chicago, gave a talk on labor economics in 1936. Advantages of higher or lower prices were discussed. He congratulated industry as a whole on the fact that the Social Security Board was headed by such a man as ex-Governor John G. Winant, and said that, from his own experience on the Labor Board, he felt that there was little liklihood of the skilled workers becoming unionized.

"Achievements in Publicity," a report by W. E. Whipp, chairman of the marketing committee, outlined the results during the short life of this group. He advocated further work along this line, particularly in educating the public to the value and necessity of machinery to counteract opposition in some quarters. Mrs. Frida Selbert showed with charts the fields where machine tools found their markets, during the past 15 months. These were based on the divisions of industry used by the survey of the *American Machinist* and the census bureau.

Industrial Review

• AFTER REACHING a peak in April which has only been touched once before since 1930, machine tool sales are apparently slowing down somewhat in May. Distributors believe that inability to make deliveries is largely responsible for the drop in orders. With few exceptions manufacturers have considerable backlogs of orders on which to work.

• IN THE EAST inquiries are excellent but closing is becoming more difficult. May started out slowly but has been gaining speed, particularly in New England. In and around New York business continues at the satisfactory level reached in April, and distributors look forward to at least one or two months more of activity. In Philadelphia the prospects are that May will be better than April. Inquiries are looking up in Pittsburgh, particularly from small concerns, many of which have been out of the market since 1930.

• CLEVELAND shops have plenty of work on hand and inquiries are active. Machine tool builders have so much work ahead that they will probably be able to keep going all through the summer regardless of any slowing down in orders that may occur. Orders are not quite as plentiful as they were in April in the Cincinnati territory but here again manufacturers are booked solid for months ahead and have, therefore, been unable to accept orders for early delivery. May business does not seem to be up to the April level. In the territory served by Indianapolis May promises to be quite as good as April and distributors of machinery report a very satisfactory situation. In and around St. Louis there has been a moderate amount of railroad buying but inquiries seem to have let up slightly. Some school business has been placed. No immediate recession is looked for.

• ORDERS FOR METAL-WORKING EQUIPMENT in Detroit are slowly rising although the day-to-day variation is wide. Distributors expect important releases, especially for toolroom equipment in the near future. The machinery business is still good in Toledo although the rate of closing inquiries is not as good as it was last year at this time. The outlook for May business in Chicago is encouraging but it does not seem likely that it will equal the very high April level. Continued small decreases are anticipated by distributors in Milwaukee but there is a fair chance that May will exceed April when the last figures are in. Machinery men there are optimistic.

Swedish Engineer Is On A.S.M.E. Program

Dallas Meeting, June 15-20, to Include Machine Shop Discussions

Machine shop practice, measurements and regulation of flow, air conditioning and educational and training sessions are included in the American Society of Mechanical Engineers Semi-Annual meeting, Dallas, Texas, June 15 to 20.

Hilding Tornebohm, Swedish industrialist, has been chosen as the Calvin Rice Memorial lecturer, and will speak Wednesday afternoon, June 17. The U. S. Army airplane maintenance system will be discussed by John H. Howard, the use of X-ray Testing of Welded Vessels will be described by H. R. Isenberger, and L. E. Kunkler will talk on Spraying Molten Metal at the machine shop session.

The first two days will be devoted to committee meetings and business sessions, a general session on the morning of June 17 opening the technical work. A part of this program, as announced by C. E. Davies, secretary, 29 West 39th St., New York, follows:

WEDNESDAY, JUNE 17.

9:30 a.m. General Session; Railroad Locomotives; Petroleum.

12:30 Luncheon, President William L. Batt, speaker.

2:00 p.m. Calvin Rice Memorial Lecture, Hilding Tornebohm.

3:15 p.m. Power; Transportation; Measurements and Regulation of Flow; Machine Shop.

THURSDAY, JUNE 18.

9:30 a.m. Petroleum; Air Conditioning; Educational and Training; Process and Power.

12:30 p.m. Luncheon meeting.

2:00 p.m. Petroleum; Process & Power; General Session; Diesel.

FRIDAY, JUNE 19.

9:30 a.m. Petroleum, Oil and Gas; Fuels and Power; Process; Hydraulic.

12:30 p.m. Luncheon.

2:30 p.m. Trips.

SATURDAY, JUNE 20.

Engineers' Day at Exposition. Dean A. A. Potter, president, American Engineering Council, speaker.

WORLD TOOL SHOW

Paris Exhibition in 1937 Is Discussed By French Manufacturers

Plans for an international machine tool show in Paris during 1937 are being studied by a group of French tool and machinery manufacturers and several interested government officials.

The show would last about 12 days, and would be held in one of the city's exposition halls or a new building erected for the purpose, preliminary discussions indicated, according to the Machinery Division, Bureau of Foreign and Domestic Commerce, U. S. Department of Commerce.

A.S.T.M. 39th Annual Meeting June 30-July 3

H. C. Parmelee and A. L. Day To Speak at Atlantic City

Dr. H. C. Parmelee, editor and publishing director, *Engineering & Mining Journal*, a McGraw-Hill publication, will be the speaker at the opening session of the 39th Annual Meeting of the American Society for Testing Materials, June 30, at Atlantic City, N. J. The sessions will continue through July 3, president H. S. Vassar has announced.

Many testing problems in the field of metals and metal working have been included on the program. Radiography, X-ray diffraction and reports of work done with gamma rays will be presented. Studies on corrosion, effect of temperature and creep will be reported on, beside the work of various committees throughout the entire week.

Dr. Arthur L. Day, director, geophysical Laboratory, Carnegie Institution, Washington, D. C., will deliver the Eleventh Edgar Marburg lecture. The Tenth Award of the Charles B. Dudley Medal will be made to H. C. Mann, research engineer, Watertown Arsenal, for his paper, "The Relation Between the Tension Static and Dynamic Tests."

Niles-Bement-Pond Merger Plan Void

Directors Abandon General Machinery Proposal

Directors of Niles-Bement-Pond Co. voted to abandon the proposed plan to merge with General Machinery Co., counsel for the company told Vice-Chancellor James F. Fielder, Chancery Court, Jersey City, N. J., whereat he discharged an order issued April 20 enjoining the company from taking any action toward the merger.

The complaint was filed by a corporation, holder of 4,000 shares of Niles-Bement-Pond common. Stockholders of General Machinery Co. had voted by more than 90 per cent approval of the merger, previously approved by a majority of Niles-Bement-Pond stockholders.

Exports of Machinery During March, 1936

	March 1936	February 1936	March 1935
Electrical machinery and apparatus	$7,560,909	$6,169,236	$6,635,810
Power generating machinery (except automotive and electric)	922,506	630,555	721,962
Construction and conveying machinery	774,957	520,511	536,163
Mining, well and pumping machinery	2,565,859	2,780,007	3,147,378
Power-driven, metal-working machinery	4,121,428	3,834,019	1,964,620
Other metal working machinery	326,672	471,815	222,156
Textile machinery	799,543	848,753	717,487

Exports of Metal-Working Machinery During March, 1936

	March 1936	February 1936	March 1935
Engine lathes	$620,898	$395,467	$85,646
Turret lathes	108,152	112,217	136,914
Other lathes	92,702	96,728	64,192
Vertical boring mills and chucking machines	109,724	232,506	37,302
Thread cutting and automatic screw machines	251,561	195,451	69,987
Knee and column type milling machines	67,899	111,952	106,961
Other milling machines	121,458	241,380	76,281
Gear cutting machines	264,781	255,368	129,417
Vertical drilling machines	43,599	76,674	12,668
Radial drilling machines	18,537	11,100	17,949
Other drilling machines	204,543	101,116	88,600
Planers and shapers	49,111	31,596	55,879
Surface grinding machines	92,008	109,422	57,574
External cylindrical grinding machines	87,919	131,362	56,140
Internal grinding machines	110,847	95,452	99,470
Tool grinding, cutter grinding, and universal grinding machines	69,665	137,719	80,203
Other metal grinding machines	90,897	61,191	65,335
Sheet and plate metal working machines	198,974	215,842	141,444
Forging machinery	195,158	152,901	255,123
Rolling mill machinery	470,039	358,726	71,327
Foundry and molding equipment	574,079	349,218	28,748
Other power driven metal-working machinery and parts	278,877	360,631	227,460
Other Metal-Working Machinery			
Pneumatic portable tools	$84,519	$55,745	$66,924
Other portable and hand or foot operated metal-working machines and parts	76,473	60,946	58,822
Chucks for machine tools	15,147	17,495	14,309
Machine operated pipe and thread cutters, stocks, dies, taps and other machine-operated cutting tools	87,953	279,211	42,601
Other metal-working machine tools	62,580	58,418	39,500

Safety Is Keynote Of S.A.E. Meeting

White Sulphur Springs Session From May 31 to June 5

The date set early to avoid conflict with new model schedules at automobile factories, the Summer Meeting of the Society of Automotive Engineers, Inc., will be held from May 31 to June 5 at the Greenbrier, White Sulphur Springs, W. Va., John A. C. Warner, secretary and general manager announced.

"Engineering for Safety and Economy in Automotive Transportation" is the theme of the meeting, and many of the nineteen sessions will be devoted to technical problems of safety in design, and three sessions will be given to highway safety problems.

A feature of the meeting will be an open forum, for members only, over which K. T. Keller, president, Chrysler Corp., will preside. H. M. Crane, past-president of the Society and technical assistant to the president, General Motors Corp., and Paul G. Hoffman, president, Studebaker Corp. of America, will serve as co-chairman. Questions of the day will be discussed "off the record."

MEXICAN PLANT BEGUN

General Motors Factory to Have 60,000 Units Capacity by Sept. 1

Mayor Cosme Hinojosa of Mexico City recently laid the corner there of the General Motors Corp. plant which will cost more than $250,000. The building will be ready Sept. 1, and its capacity will be about 60,000 trucks per year. Later, it is expected, the plant will be expanded to assemble passenger cars.

PERSONALS

ROY E. ADAMS, has been elected president of J. D. Adams Mfg. Co., Indianapolis, Ind., road building and construction machinery makers. WILLIAM RAY ADAMS was elected first vice president; HOWARD R. MEEKER, second vice-president and secretary; FLOYD D. WALLACE, third vice-president; W. W. WHITE, treasurer.

C. J. BRUCKNER has been elected president of Waco Aircraft Co., Troy, Ohio. LEE N. BRUTUS was named vice-president and treasurer, and L. E. ST. JOHN was elected secretary at the recent annual meeting.

A. R. CARSON, assistant superintendent of motive power shops, Canadian National Railroad, Moncton, N. B., has been appointed superintendent of shops.

JOHN DOLZA, for the past two years designing engineer of Buick Motor Co., Flint, Mich., has been appointed assistant chief engineer, of Buick.

BENJAMIN B. GRACIER, for twenty years with Caterpillar Tractor Co. and one of its predecessors, C. L. Best Tractor Co., has been appointed factory manager of the company's road machinery plant. He joined the Best organization as a machinist.

L. W. GROTHAUS, assistant to the president, Allis-Chalmers Mfg. Co., Milwaukee, has been elected a vice-president.

ELY C. HUTCHINSON, formerly editor of *Power*, a McGraw-Hill publication, has joined the staff of the J. G. White Engineering Corp., 80 Broad St., New York. An engineering executive of wide experience, Mr. Hutchinson was

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for many years connected with Cramp-Morris Industrials, Inc., Philadelphia, was president of Pelton Water Wheel Co., San Francisco, and head of Edge Moor Iron Co., Edge Moor, Del., until 1934. Active in several technical societies, he is chairman of the American Society of Mechanical Engineers power test code committee.

ALFRED LAPIERRE, for a number of years superintendent of the gage department, Greenfield Tap & Die Co., Greenfield, Mass., has been appointed manager of the company's new plant, recently acquired from the J. M. Carpenter Tap & Die Co., 2120 West Fort St., Detroit. VERSIL ANNIS has been named office and merchandise manager; GLENN STIMSON will have charge of engineering, and ROY PETERSON heads the metallurgical work. The Carpenter office and factory employees will be retained. AL KIEHNE, formerly with Greenfield and later with the Carpenter concern, will continue as chief inspector.

JOHN A. MACMILLAN, formerly president, has been elected chairman of Dayton Rubber Mfg. Co., Dayton, Ohio, manufacturers of transmission drives. A. L. FREEDLANDER, for the past 16 years vice-president, was named president.

CHARLES W. MATTHEWS, Louisville & Nashville Railroad master mechanic, has been appointed to the new position of general master mechanic, with headquarters at Louisville. Joining the railroad in 1900, he served as machinist until 1904 and was steadily advanced by several lines for whom he worked, and was appointed master mechanic of the L. & N. at Decatur, Ala., in 1919.

C. N. MONTEITH, since 1927 chief engineer of Boeing Aircraft Co., Seattle, has been elected executive vice-president. He joined the company in 1920 after serving as chief of the airplane section, engineering division, U. S. air service, McCook Field. R. J. MINSHALL, who has been with the company since 1918, becomes chief engineer.

C. A. PEASE has been appointed terminal foreman of the New York Central at Marmon, N. Y. He has been assistant foreman of the enginehouse at East Buffalo, N. Y.

GERALD V. RONEY, has been appointed manager of Farland & Delorme, Ltd., metal work manufacturers, Montreal, Que.

A. C. SCHROEDER, production inspector, car department, Chicago, Milwaukee, St. Paul & Pacific Railroad, has been named general foreman of the freight car shop at Milwaukee.

Professor BRADLEY STOUGHTON, head of the department of matallurgy, Lehigh University, has been appointed the university's first dean of engineering. He joined the Lehigh faculty in 1923.

EMIL C. TRANER, Rockford, Ill., has been elected president of Mechanics Universal Joint division, Borg-Warner Corp., Chicago, succeeding the late ERIC ERSTROM.

WALTER WHITE has been appointed general superintendent of Pittsburgh Rolls Co., Pittsburgh.

ROBERT J. WILSON, formerly president, Kempsmith Mfg. Co., Milwaukee, milling machine manufacturer, and executive vice-president, Endestro Mfg. Co., Chicago, has been appointed general manager of Western Metal Specialty Co., Milwaukee, metal stamping manufacturer.

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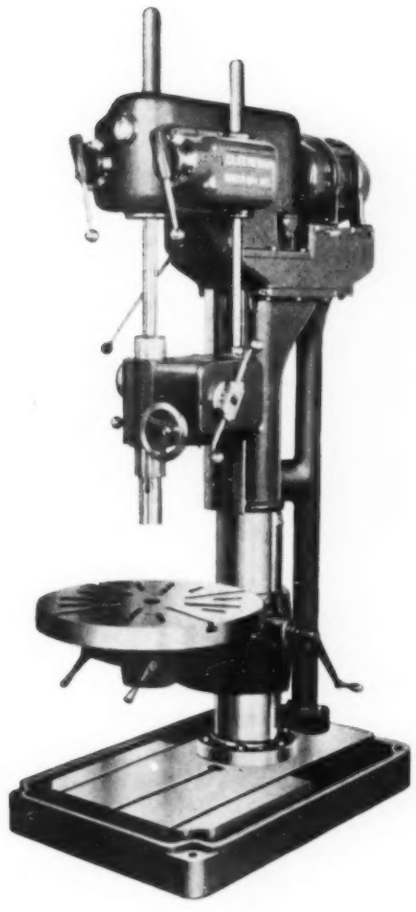

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BUSINESS ITEMS

William K. Stamets, Pittsburgh, has appointed V. A. Root, formerly with W. F. & John Barnes Co., Rockford, Ill., a member of its Cleveland sales staff.

Horace R. Whittier Co., Pequabuck, Conn., is building a two-story brick addition to its metal-working and enameling plant. The building, 160 by 40 ft., will house the machine and tool departments and the press room. Business during the past two years has greatly increased, Horace R. Whittier, vice-president, announced.

Union Twist Drill Co., Athol, Mass., has opened a new store at 61 Reade St., New York, N. Y., with a complete stock of the company's line of twist drills, taps, dies, milling and gear cutters and tool grinding machines.

DeJur Amsco Radio Corp. has been organized with a capital of $100,000, to manufacture automotive, electrical and radio parts. Machinery will be installed in a plant at Shelton, Conn.

Torrington Co., Torrington, Conn., and Bantam Ball Bearing Co., South Bend, Ind., have appointed C. W. Dietrich, Jr., sales engineer for their swaging machines and ball and roller bearings with headquarters at 200 Fifth Ave., New York.

American Engineering Co., Philadelphia, Pa., has appointed John F. Cooke head of hoist, pump and marine sales. The company has moved its New York sales office from 40 West 40th St., to larger quarters at 75 West St., New York.

P & H Electric Motor Sales Division of Harnischfeger Corp., Milwaukee, has appointed Charles R. Surface sales manager with offices at 4460 West National Ave., the company's headquarters.

National Acme Co., 170 East 131st St., Cleveland, has appointed W. S. Chase, for many years sales manager of the company, sales manager for the West Coast district, with office at 106 South Cordova St., Alhambra, Calif.

Narragansett Products Corp., formerly at 55 Pine St., has moved to its own and enlarged plant at 45 Baker St., Providence, R. I., John M. Washburn, president, announced. The company manufactures machine parts and metal specialties.

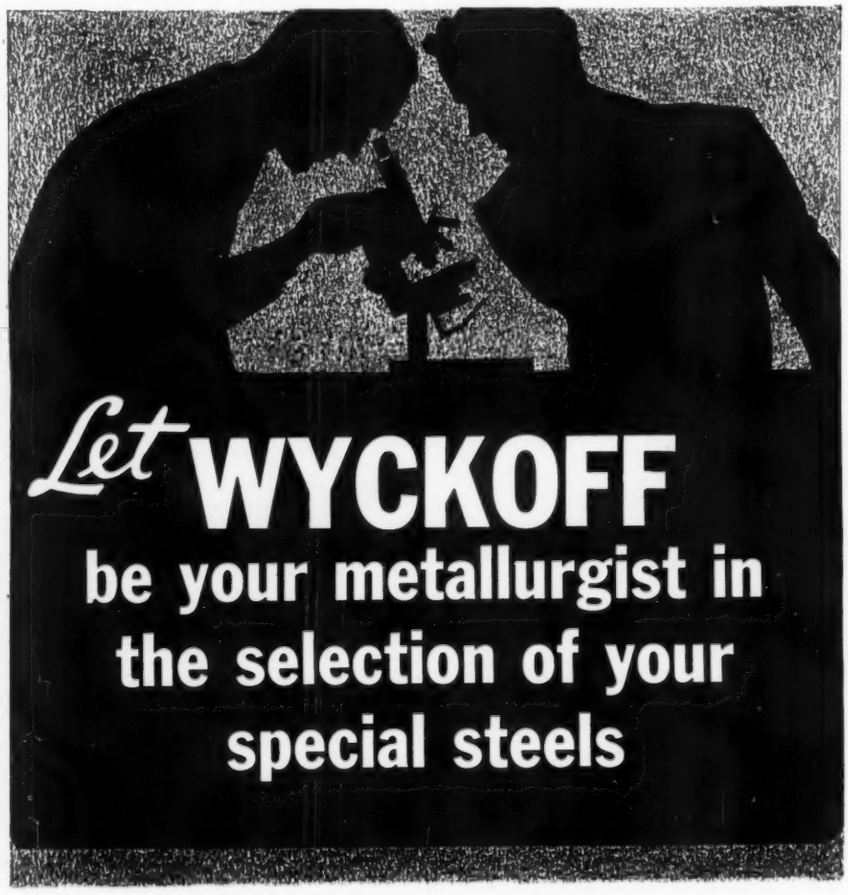
New Departure Mfg. Co., Bristol, Conn., has moved its Chicago sales engineering office to 230 North Michigan Ave.

Ingersoll Milling Machine Co., Rockford, Ill., has appointed Frank Burgan its representative in Indiana and Ohio. Mr. Burgan has been assistant manager of the small tool division of the company.

Link-Belt Co., 307 North Michigan Ave., Chicago, has appointed Industrial Supplies, Inc., Poplar Ave. and River Front, Memphis, Tenn., its authorized stock-carrying distributor in that territory.

Greenfield Tap & Die Corp., Greenfield, Mass., has appointed John Penny, for a number of years in charge of Detroit sales, district sales manager of its Detroit office. Messrs Richmond and Willis, formerly with the J. M. Carpenter Tap & Die Co., recently acquired by Greenfield, will be associated with him.

Allegheny Steel Co., Pittsburgh, have reopened their Cleveland downtown office at 1621 Euclid Ave.



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General Offices: First National Bank Bldg., Pittsburgh, Pa.
Mills at Ambridge, Pa. and Chicago, Ill.
Manufacturers of Cold Drawn Steels
Turned and Polished Shafting Turned and Ground Shafting

OBITUARIES

ALBERT W. ADT, 72, for 15 years president, John B. Adt Machinery Co., Baltimore, died April 26. His father founded the tobacco machinery firm in 1865.

CLAUDE BETHEL, 45, manager of the railway engineering department, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., died recently after a short illness. He joined the company in 1919.

T. E. BINGHAM, managing director, Barber Coleman, Ltd., Manchester, England, died March 6. He had been with the company for 30 years.

JOHN B. BOSEL, 60, for the past five years superintendent, Dornbirer Machine Tool Co., died April 24. He had been with the Bailey Meter Co. and Cleveland Automatic Machine Co.

WILLIAM S. CORBITT, vice-president, Corbitt Co., motor truck manufacturer, Henderson, N. C., died May 8 there.

ALLAN CUNNINGHAM, 54, founder, Allan Cunningham Co., Seattle, hoist, derrick and marine equipment manufacturer, died April 23.

BURTON L. DELACK, until two years ago manager of the Schenectady Works of General Electric Co., and more recently assistant to W. R. Burrows, vice-president, died May 7.

WILLIAM F. FOLMER, 74, designer of manufacturing machinery, inventor of the Graflex camera and more than 300 devices ranging from bicycle mechanisms to aerial photographic equipment, died May 7, in Rochester.

E. M. FORSYTHE, maintenance engineer, Southside plant, Kennedy Valve Mfg. Co., Elmira, N. Y., formerly in charge of the pattern shop, Willys-Morrow Co., Elmira, died recently.

EARL V. HENNECKE, 52, president and an organizer of Automotive Equipment Co., Long Island City, N. Y., died May 11. A former director of the Motor & Equipment Manufacturers Association, he had been vice-president of Moto Meter Co., and a member of former President Hoover's committee on industrial standardization.

OTTO HORIX, 63, president, Horix Mfg. Co., Pittsburgh, packaging machinery and equipment manufacturer, died April 30.

WILLIAM O. JACQUETTE, 70, until seven years ago president of Manning, Maxwell & Moore Co., machinery and railroad supply firm, died May 8. Earlier in his career he had been an executive of Fox Pressed Steel Co.

WALTER H. MOORE, 56, Cleveland district manager, Haynes Stellite Co., died April 9. He joined the company in 1923, and had been production manager of Foote-Burt Co., and tool supervisor for F. B. Stearns Co., Cleveland.

JOHN D. MURRAY, 83, retired superintendent of Girard Wrench Mfg. Co., Girard, Pa., died recently following a long illness. He joined the company in 1877.

JOSEPH M. OLIVER, 72, founder of the Oliver Machinery Co., Grand Rapids, Mich., died April 12 in Florida. He retired about 20 years ago.

FREDERICK J. RUNSER, 52, former president, Cuyahoga Machine & Tool Co., died April 12 in Cleveland, Ohio.

GUSTAVE SITTMAN, 72, inventor of automatic screw machinery and designer of special machinery, died in New York April 24.

Expert Flame Cutting Service Reduces Manufacturing Costs

Intricate Parts Quickly Cut From Steel Plates—all grades

Ryerson Flame Cut Plates are saving both time and money for many manufacturers. The most experienced operators with modern and complete equipment are continually producing parts meeting the most exacting specifications. Large stocks of steel—mild, high carbon and alloy grades—assure immediate production of your requirements. Let us show you what this Ryerson service can save you. Send sketch or blue print for quotation and ask for bulletin showing many different parts now being produced in Ryerson shops.

Joseph T. Ryerson & Son, Inc., Chicago, Milwaukee, St. Louis, Detroit, Boston, Cleveland, Cincinnati, Buffalo, Philadelphia, Jersey City.

RYERSON STEEL-SERVICE

MEETINGS

AMERICAN ELECTRO-PLATER'S SOCIETY. 24th Annual Convention, June 1-4, Hotel Carter, Cleveland, Ohio.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Summer Meeting, June 15-20, Dallas, Texas. C. E. Davies, Secretary, 29 West 39th St., New York, N. Y.

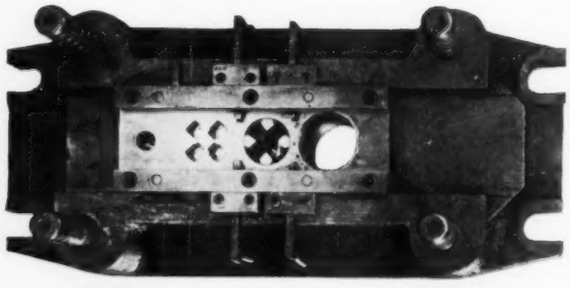
SCIENTIFIC APPARATUS MAKERS OF AMERICA. Annual Meeting, June 1-3, Edgewater Beach Hotel, Chicago, Ill. J. M. Roberts, Secretary, 20 North Wacker Dr., Chicago, Ill.

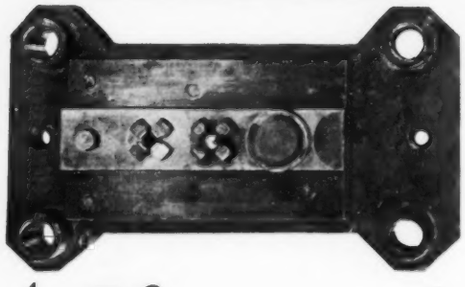
SOCIETY OF AUTOMOTIVE ENGINEERS, INC. Summer Meeting, May 31-June 6, White Sulphur Springs, W. Va. John A. C. Warner, Secretary-General Manager, 29 West 39th Street, New York, N. Y.

AMERICAN SOCIETY FOR TESTING MATERIALS. 39th Annual Meeting, June 29-July 3, Atlantic City, N. J. C. L. Warwick, Secretary-Treasurer, 260 South Broad St., Philadelphia, Pa.

NATIONAL ASSOCIATION OF PURCHASING AGENTS. 21st Annual International Convention and Inform-A-Show, May 25-28, New Orleans, La. G. A. Renard, executive secretary-treasurer, 11 Park Place, New York.

Hub Cap forming dies





4 Reasons why

O-HI-O AIR DIE

WAS SELECTED *for* THIS JOB

1. annealed comparatively soft
2. machined without difficulty
3. no movement or warpage in hardening
4. desired hardness by cooling in still air

COLONIAL STEEL CO.

PITTSBURGH, PA.

EXPORT OPPORTUNITIES

Presses, automatic, for making small aluminum containers. (Purchase.) Prague, Czechoslovakia. *496.

Industrial machinery, printing equipment, used. (Agency.) Mexico City, D.F., Mexico. *479.

Road machinery, bitumen plant equipment, crawler and industrial tractors. (Purchase & Agency.) Johannesburg, South Africa. *497.

Air conditioning machinery. (Agency.) Bratislava, Czechoslovakia. *478.

Engines, for using hydrogen. (Purchase.) Guatamala City, Guatamala. *482.

Electrostatic separator for powdered ore. (Purchase.) Barcelona, Spain, *526.

Engines, gasoline, stationary and portable. (Purchase.) Prague, Czechoslovakia. *528.

Engines, oil, stationary. (Purchase.) Johannesburg, South Africa. *527.

Floor scraping and sanding machines. (Agency.) Zagreb, Yugoslavia. *525.

Textile (cotton) machinery, automatic looms, thread reelers and winders; dyeing equipment. (Purchase.) Capetown, South Africa. *523.

Thumb tack manufacturing machinery. (Purchase.) Plzen, Czechoslovakia. *529.

Electrical machinery. (Purchase.) Zagreb, Yugoslavia. *558.

Collapsible tube manufacturing machinery and lithographing equipment for tubes. (Purchase.) Santiago, Chile. *615.

Engines, diesel, for powering concrete mixers. (Purchase.) London, Canada. *581.

Machine Tools. (Agency.) London, England. *602.

Paint manufacturing machinery. (Purchase & Agency.) London, England. *601.

Paint and varnish manufacturing machinery. (Agency.) Paris, France. *600.

*Interested American firms and individuals may obtain the names and addresses of the foreign firms making these inquiries upon application to the Bureau of Foreign and Domestic Commerce, U. S. Department of Commerce, Washington or any district or cooperative office. Please refer to key number.

Machine Requirements and Industrial Construction

EQUIPMENT WANTED

Conn., South Windsor—Town, East Windsor Hill, will soon take bids for manual training equipment and drafting room supplies. W. T. Marchant, 36 Pearl St., Hartford, Archt. and Engr.

Ind., Anderson—Auto Electric Service Co., J. D. Hopper, Mgr., 18th and Jefferson Sts.—general machine tools and all tools used for repairing all makes of tractors.

Ind., Anderson—Pierce Governor Co., E. R. Watkins, Engr., 1525 Ohio Ave.—drill presses, automatics and others used in making automatic chokes for automobiles.

Mass., Springfield—Col. T. J. Smith, Commanding Officer, Springfield Armory, will receive bids until May 25 for one double crank, straight sided, motor driven press.

Mich., Birmingham — Rufus D. Brown, Box 204—one power heavy duty punch and shear machine for punching round and square holes in tempered steel; one heavy duty power trip hammer; one heavy duty drill press with tools and all equipment; one power hacksaw for sawing unannealed alloy steel for 14 in. highspeed saws.

Mich., Detroit — Lamb Co., 6343 Wight St.—one boring mill, Lucas or similar make.

Mo., St. Louis—Atlas Tool & Manufacturing Co., G. A. Delf, Pres., 6319 Manchester Ave.—equipment and tools for new plant at 5145 Natural Bridge Ave. Estimated cost $25,000.

O., Cleveland—Advance Die & Tool Co., 7114 Lawn Ave.—50 to 75 ton inclinable punch press, stroke 4 to 5 in., bed 20x30; also vise for 20 in. shaper; dividing head for milling machine; 18 or 20 in. circular table.

O., Cleveland—Royal Brass Mfg. Co., 1420 East 43rd St.—shaper with 12 to 16 in. stroke, belt drive type.

O., Fairport—Neal Printing Co., 310 High St.—12x18 in. printing press, type cabinets and other print shop machinery and equipment.

N. Y., Buffalo—Samuel Greenfield Co., Inc., Gilbert St.—machinery, including furnaces, etc., for smelting non-ferrous metals for installation in former Kellogg Structural Steel Co. plant on Bailey Ave. to be operated by owner as branch plant.

N. Y., Erin—Lee Wheaton—complete machinery and equipment for saw mill.

N. Y., Fort Plain—Clyde-Bank Knitting Co., Inc., W. R. Ronald, Supt., Upper Canal St.—knitting machines and other equipment for hosiery mill.

N. Y., North Clymer—E. A. Reed—complete machinery and equipment for saw mill.

N. Y., Westfield—J. Vernon Wantshouse—18 in. planing machine; band saw; swinging cut-off saw.

N. Y., West Leyden—Rimiller Box Co., I. J. Rimiller, Mgr.—planer, printing press, dry kiln and other smaller machinery for manufacture of cheese boxes.

Pa., Cambridge Springs—Standard Trailer Co.—woodworking machinery and equipment.

Pa., Butler—G. E. McKey, 120½ New Castle St.—drilling machine with tools and equipment for well drilling.

Pa., Erie—J. J. Divell, 512 East 29th St.—electric drill.

Pa., Lock Haven—Porter Welding Shop, E. R. Porter—complete machinery and equipment for welding shop.

Pa., Nanticoke—Pure Ice Co. of Nanticoke, W. Samuels, Mgr.—complete machinery and equipment for garage including air compressor, crane, hoists, small tools and other mechanics' equipment.

Pa., Scranton — Scranton School District, J. Eckersley, Secy., will take bids in summer for complete machinery and equipment for vocational and manual training department for new junior high school.

Pa., Williamsport — Smith-Levin-Harris Co., U. S. Rubber Bldg.—60 new industrial sewing machines.

Pa., Williamsport—Williamsport Narrow Fabric Co., 496 Bridge St.—125 new textile machines and other equipment for addition to plant now under construction.

Que., Montreal — H. V. Bernier, 4874 Park Ave.—one 12 in. power driven press drill; one 100 hp. locomotive or scotch marine boiler for 100 lb. working pressure; one 50 or 75 hp. steam engine.

OPPORTUNITIES FOR FUTURE BUSINESS

Calif., Beverly Hills—Payne Furnace & Supply Co., 338 North Foothill Rd., has awarded the contract for the construction of a factory and office addition. Estimated cost will exceed $37,500. Noted Mar. 25.

Calif., Davis—State of California will construct a 1 story, 75x100 ft. machine shop and truck corps unit at the University Farm, here. Work will be done by day labor under supervision of J. Jacobson, Supt. of Construction.

Calif., Los Angeles—Studebaker Motors Corp., 4530 Loma Vista Ave., plans to construct an addition to its plant in the Central Manufacturing District for the manufacture of automobile bodies. Estimated cost $1,000,000.

LUFKIN

TAPES - RULES - PRECISION TOOLS

Your Tool Room needs a set of LUFKIN MICROMETERS

Set illustrated No. 191E 0 to 12 inch

For final checking purposes every well equipped Tool Room should have a set of accurate Micrometers

LUFKIN Micrometers are the last word for accuracy, long wear and ease of adjustment. The measuring screws are uniform in accuracy throughout their entire length; the anvil and spindles are of special hardness steel to give unusually long wear; the patented adjustment feature makes it a simple matter to keep the Micrometer in absolute adjustment at all times and the reading line remains in its original position throughout the life of the Micrometer.

Micrometer Sets are available in various combinations:

0 to 3 inch — 0 to 6 inch — 6 to 12 inch — 0 to 12 inch

Specify LUFKIN Tools For Your Shop Equipment

Send for Tool Catalog No. 7

NEW YORK: 106-110 Lafayette St.

THE LUFKIN RULE CO. SAGINAW, MICHIGAN, U. S. A.

Canadian Factory WINDSOR, ONT.

Calif., San Leandro—Friden Calculating Machine Co., 1 Montgomery St., plans to construct a 1 story, 75x265 ft. factory on Washington Ave. Estimated cost $50,000.

Conn., East Hartford — Hamilton Standard Propeller Co., 400 South Main St., will soon award the contract for the construction of a plant for the manufacture of airplane propellers. Estimated cost will exceed $40,000.

Conn., Stamford—Pitney Bowes Postage Meter Co., J. H. Williams, Mgr., 763 Pacific St., plans to construct a 2 story addition to its factory. Estimated cost will exceed $37,000.

Conn., Waterbury—American Brass Co., West Main St., will construct a 1 story, 70x240 ft. factory addition, to include platform, freight and loading facilities. Estimated cost $37,000.

Ia., Des Moines—New Monarch Machine & Stamping Co., 406 S.W. 9th St., plans to reconstruct plant No. 2. Estimated cost including equipment $38,000.

Ia., Des Moines — Western Silo Co., 1003 Murphy St., contemplates the construction of a factory. Estimated cost including equipment $38,000.

Mich., Detroit — Chrysler Corp., 341 Massachusetts Ave., has awarded the contract for the construction of an addition to its foundry and machine shop on East Jefferson Ave. Estimated cost $100,000.

Mich., Detroit—Chrysler Corp., 341 Massachusetts Ave., is receiving bids for the construction of a press shop on Wyoming Ave. Estimated cost $100,000. Albert Kahn, Inc., New Center Bldg., Archt.

in the foremost machine tool equipment

In adopting Laminum precision adjustment shims the foremost machine tool manufacturers are giving users a feature that cuts maintenance costs and saves production hours throughout the life of the equipment.

Precision bearing, gear, shaft and interchangeable unit adjustments are made right at the machine . . . No longer need you remove parts (or solid shims) to the shop for filing, machining or grinding.

.002" or greater adjustments by simply p-e-e-l-i-n-g one or more laminations at a time from the Laminum shim. Sample on request.

The solid shim that p-e-e-l-s for adjustment

LAMINUM

LAMINATED SHIM CO. 2114-44th Av., Long Island City, N. Y

Cleveland Detroit Milwaukee

591

Mich., Detroit—Packard Motor Car Co., East Grand Blvd., has awarded the contract for the construction of a foundry on Strong Ave. Estimated cost $96,000.

Mich., Flint—Buick Motor Co. plans to construct extensions to its forge plant including new heat treating equipment. Separate contracts have been awarded for the work. Estimated cost will exceed $37,000.

Mich., Midland—Midland Steel Products Co., Mt. Elliott Ave., has awarded the contract for the construction of an addition to its plant. Estimated cost $50,000.

Mo., St. Louis — James R. Kearney Corp., 4236 Clayton Ave., has awarded the contract for the construction of a 2 story, 65x125 ft. addition to its electric appliance plant.

Mo., St. Louis—Krans Automotive Body Co., 3032 Gravois Ave., will soon take bids for the construction of a 1 story, 24x125 ft. addition to its factory.

Mo., St. Louis—Lincoln Engineering Co., 5701 Natural Bridge Ave., has awarded the contract for the construction of a 1 story, 90x120 ft. addition to its factory to be used for the manufacture of lubricating equipment.

Mo., St. Louis—Southern Equipment Co., 5017 South 38th St., has awarded the contract for the construction of a 1 story, 40x155 ft. tin shop addition.

Mont., Billings — City, R. T. Hurdle, City Engr., voted $50,000 bonds to construct 30x128 ft. machine shop and 100x128 ft. additional hangar.

Mont., Helena — Northern Pacific R.R., B. Blum, Ch. Engr., St. Paul, Minn., plans to improve its shops here. Work will be done by day labor and separate contracts. Estimated cost $38,000.

Mont., Livingston—Northern Pacific R.R., B. Blum, Ch. Engr., St. Paul, Minn., plans to improve its shops here. Work will be done by day labor and separate contracts. Estimated cost including equipment $37,000.

N. H., Berlin—City, A. J. Burgeron, Mayor, City Hall, plans to construct a work shop at the City Yard. Estimated cost $85,000. P. Murphy, City Engr.

N. Y., Dunkirk — Dunkirk Radiator Co., Middle Rd., will construct an addition to its factory for the manufacture of home heating boilers. Work will be done by day labor and separate contracts. Estimated cost will exceed $37,000.

N. Y., Dunkirk—Ludlum Steel Co., 66 Howard Ave., has awarded the contract for an addition to its factory. Estimated cost $50,000.

N. Y., New York—Department of Parks, Arsenal Bldg., Central Park, is having plans prepared by A. Embury, Archt., c/o Owner, for the construction of boat repair shops on Randalls Island. Estimated cost $75,000.

N. Y., Sidney—Scintilla Magneto Co. plans to construct an addition to its plant here. Estimated cost will exceed $37,000.

N. Y., Watertown—Stebbins Engineering & Manufacturing Co., Trust Co. Bldg., plans to construct three 1 story additions to its plant. Owner will purchase materials and build with own forces. Estimated cost will exceed $37,000.

O., Cleveland—Thornton Co., F. A. McCloud, Pres., 3441 East 76th St., manufacturer of sheet metals, has awarded the contract for an addition to its factory. Estimated cost $30,000.

O., Cleveland—Willard Storage Battery Co., East 131st St. and St. Clair Ave., has awarded the contract for an addition to its factory. Estimated cost will exceed $28,000. Noted Apr. 22.

O., Dayton—Chrysler Corp. (Air Temperature Corp.), 341 Massachusetts Ave., Detroit, Mich., has awarded the contract for the construction of a plant for the manufacture of air conditioning equipment on Leo St. Estimated cost $65,000.

Pa., Millvale—Duquesne Mine Supply Co., 2 Cross St., plans to construct a 1 story manufacturing building.

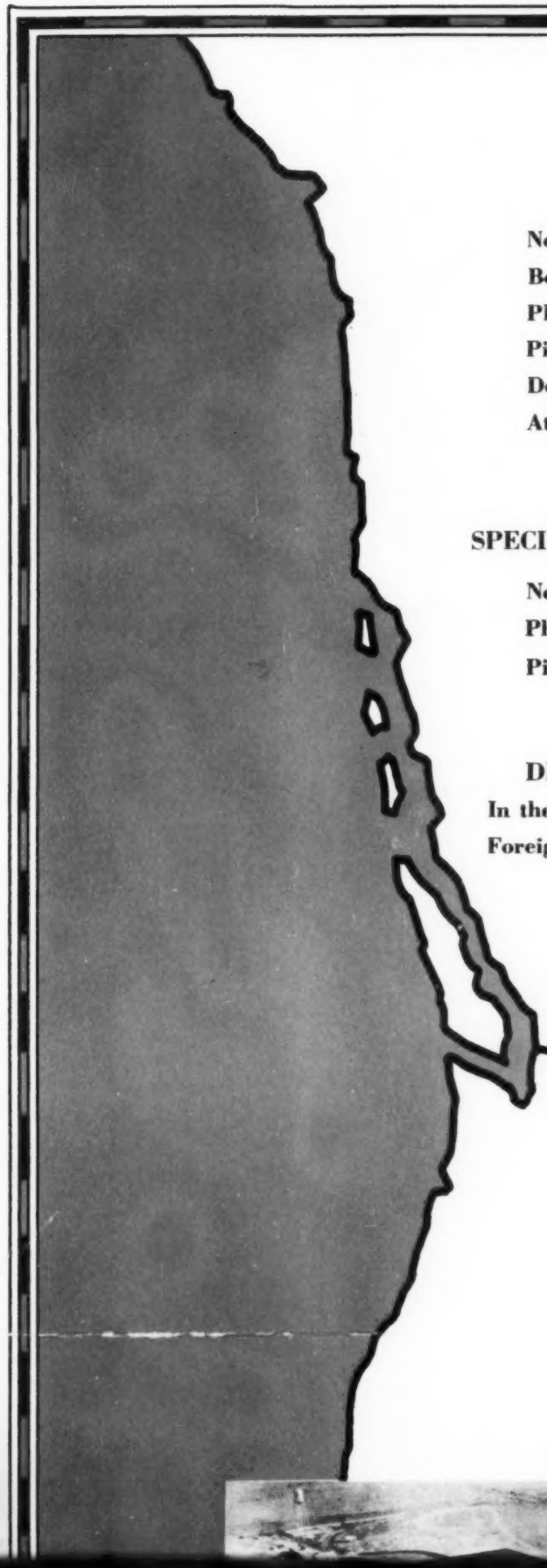
Pa., Walnutport — American Nickeloid Co., Walnutport, plans to construct a 1 story addition to its plant. Considerable new machinery and equipment will be installed.

Wis., Beloit—Electric Equipment Mfg. Co., Beloit, will soon take bids for the construction of a 1 story, 150x200 ft. factory.

Wis., Beloit—Fairbanks Morse & Co., Beloit, and 900 South Wabash Ave., Chicago, Ill., has awarded the contract for the construction of an addition to its plant here. Estimated cost including equipment $100,000.

Wis., Milwaukee—Chain Belt Co., 1600 West Bruce St., plans to construct an addition to its plant at West Milwaukee. Estimated cost $50,000.

Chrysler



PARTS DEPOTS

New York	Chicago
Boston	St. Louis
Philadelphia	Kansas City
Pittsburgh	Dallas
Detroit	Minneapolis
Atlanta	Seattle

Los Angeles

SPECIAL FACTORY SALES BRANCHES

New York	Detroit
Philadelphia	Chicago
Pittsburgh	Kansas City

DEALERS AND DISTRIBUTORS

In the United States 12,600

Foreign including Canada 7,000

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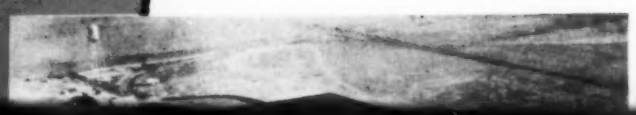

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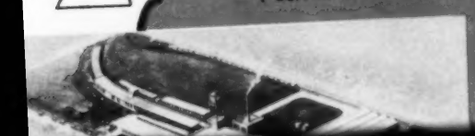
Kercheval Plant

New Windsor Plant

(Canada)



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Kercheval Plant

New Windsor Plant

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(Antwerp)

LONDON ★

ANTWERP ★

s, Ltd. Plant

Los Angeles Plant

Wyomin

New Castl

★LOS ANGELES

Distributor Assembly Plants Where Chrysler Corporation's Products Are Assembled Abroad

1 Christchurch, New Zealand
2 Wellington, New Zealand
3 Rio de Janeiro, Brazil
4 Buenos Aires, Argentina
5 Dublin, Ireland
6 Cork, Ireland
7 London, England
8 Antwerp, Belgium
9 Oslo, Norway
10 Stockholm, Sweden
11 Copenhagen, Denmark
12 Madrid, Spain
13 Arbon, Switzerland
14 Bucharest, Roumania
15 Bombay, India
16 Delhi, India
17 Madras, India
18 Calcutta, India
19 Nairobi, British E. Africa
20 Dairen, Manchuria
21 Shanghai, China
22 Tokyo, Japan
23 Osaka, Japan
24 Manila, P. I.
25 Perth, Australia
26 Hobart, Australia
27 Adelaide, Australia
28 Melbourne, Australia
29 Sydney, Australia
30 Brisbane, Australia

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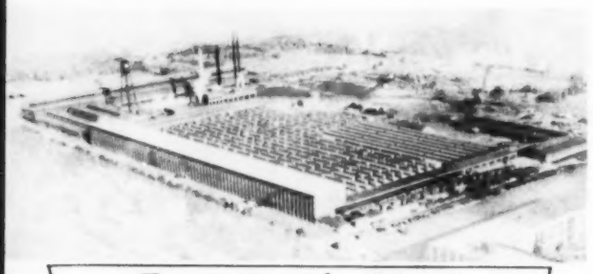
Wyoming Plant



New Castle Plant

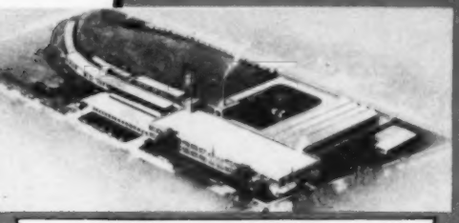
Evansville Plant

Dayton Plant

Supplement to
American Machinist
MAY 20, 1936

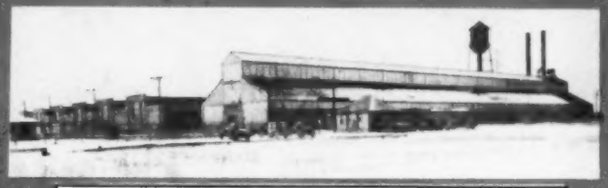
New Windsor Plant

(Canada)

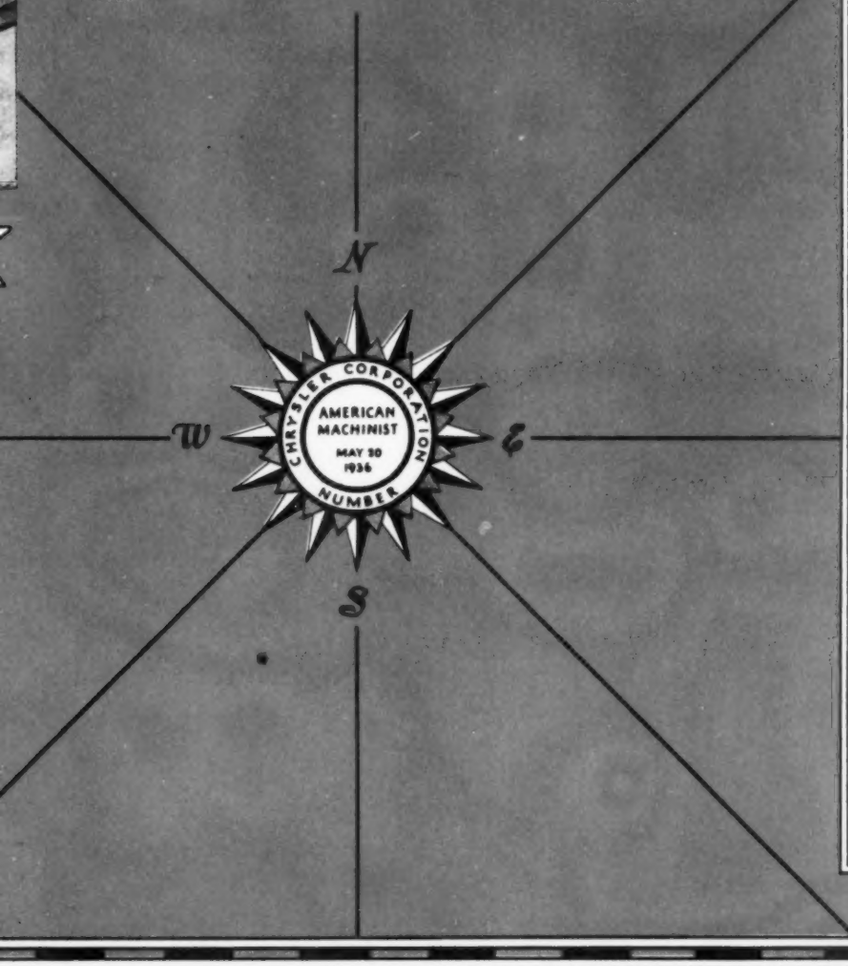


Windsor Plant

(Canada)



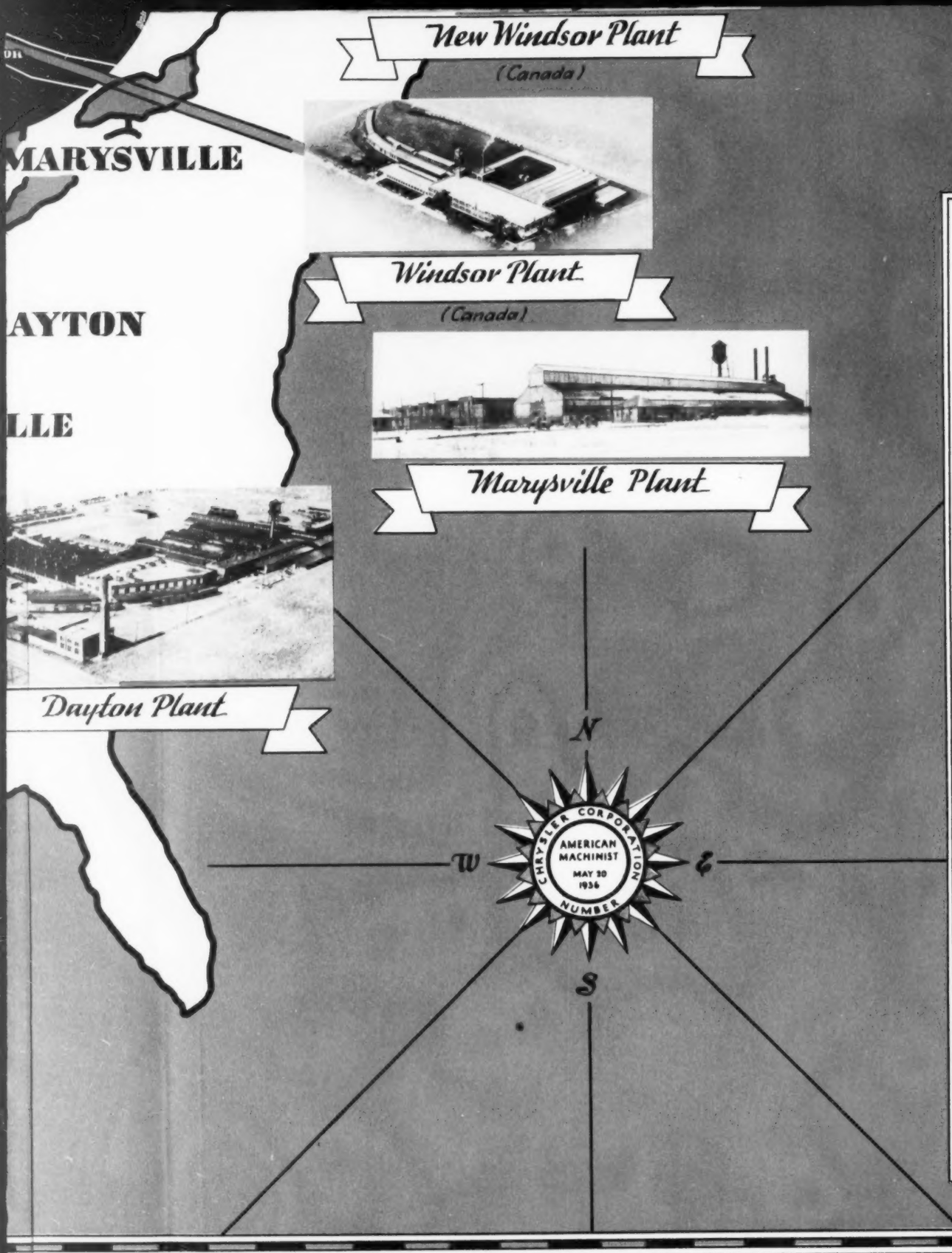
Marysville Plant



CHRYSLER CORPORATION MANUFACTURING

Their Size and What They Make

PLANT	AREA IN SQ. FT.	PRODUCTS
Dodge Main	4,556,151	Dodge Passenger Ca Sub-Assemblies Chrysler Corpora
Plymouth	986,050	Plymouth Cars
Jefferson	1,540,247	Chrysler and De So
Kercheval	754,290	Bodies for Chrysle and Some Plymo
Dodge Truck	556,796	Dodge Trucks
Highland Park	1,814,595	Service Parts
Dodge Forge	278,135	Forgings
New Castle	513,578	Gears, Axles, Forgi Machined Parts
Evansville	551,383	Plymouth Assembl
Los Angeles	293,776	Dodge Truck and Assembly Branc
Wyoming	463,390	De Soto Assembly
Amplex	199,910	Marine and Indust and Specialties
Dayton	200,000	Heating and Air-Co Apparatus
Marysville		Sheet Metal Parts Enameling
Windsor (Canada)	224,977	Service Parts and Assembly for Ca
New Windsor (Canada)	306,667	Assembly of Chrys Dodge and Plym
London (England)		Assembly and Pa ture for Cars a Delivered in Br
Antwerp (Belgium)		Main Assembly and Center for Euro



CHRYSLER CO

PLANT	
Dodge Main	
Plymouth	
Jefferson	
Kercheval	
Dodge Truck	
Highland Park	
Dodge Forge	
New Castle	
Evansville	
Los Angeles	
Wyoming	
Amplex	
Dayton	
Marysville	
Windsor (Canada	
New Windsor (Canada)	
London (England	
Antwerp (Belgiu	

LER CORPORATION MANUFACTURING PLANTS

Their Size and What They Make

NT	AREA IN SQ. FT.	PRODUCTS
Main	4,556,151	Dodge Passenger Cars, Parts and Sub-Assemblies for Other Chrysler Corporation Cars
th	986,050	Plymouth Cars
n	1,540,247	Chrysler and De Soto Cars
al	754,290	Bodies for Chrysler, De Soto and Some Plymouth Cars
Truck	556,796	Dodge Trucks
d Park	1,814,595	Service Parts
Forge	278,135	Forgings
tle	513,578	Gears, Axles, Forgings and Machined Parts
lle	551,383	Plymouth Assembly Branch
geles	293,776	Dodge Truck and Plymouth Assembly Branch
g	463,390	De Soto Assembly
.....	199,910	Marine and Industrial Engines and Specialties
.....	200,000	Heating and Air-Conditioning Apparatus
lle		Sheet Metal Parts Painting and Enameling
(Canada)...	224,977	Service Parts and Truck Assembly for Canada
ndsor ada)	306,667	Assembly of Chrysler, De Soto, Dodge and Plymouth Cars
(England)		Assembly and Parts Manufacture for Cars and Trucks Delivered in British Isles
(Belgium)		Main Assembly and Distributing Center for Europe

LITHO. IN U.S.A.